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Assessing Biological Diversity in the United States: Data Considerations

Background Paper #2

CONGRESS OF THE UNITED STATES
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Preface

Biological diversity is crucial to human welfare. To maintain biological diversity requires an understanding of the components of biological systems and how they interact. Such an understanding is possible only if data are available to document the species, communities, and ecosystems that make up the biological systems. In recent years increasing efforts are being made to collect biological data in the United States. While enormous quantities of biological data now exist, several factors limit the data's usefulness in the task of maintaining biological diversity. Various laws require or authorize Federal agencies to collect biological data or to maintain biological databases, but few of these mandates apply directly to biological diversity. Consequently, maintaining diversity is seldom a goal of data collectors. Furthermore, there is no overall institutional coordination of biological data-collection efforts, which means that data are scattered, maintained in various forms, and stored in different—often incompatible—systems, even within one agency. There are gaps and overlaps in coverage, and it is difficult to ascertain what data are available.

This background paper outlines how data can be used in maintaining biological diversity; describes primarily the Federal institutions that collect biological data; provides an overview of existing Federal biological databases; discusses technical aspects of collecting, storing, and retrieving biological data; and suggests ways to improve biological databases so that they can be better used to help maintain diversity of this Nation's plant and animal life.

This paper is part of the Office of Technology Assessment's forthcoming assessment of *Technologies To Maintain Biological Diversity*. A concurrent background paper, *Grassroots Conservation of Biological Diversity in the United States*, illustrates the contributions of a growing number of individuals and citizen-based groups to the maintenance of biological diversity. This assessment was prepared by OTA in response to requests from the House Committee on Science and Technology, Senate Committee on Foreign Relations, and the Senate Committee on Agriculture, Nutrition, and Forestry, and supported by the House Committee on Foreign Affairs, House Committee on Merchant Marine and Fisheries, and House Committee on Agriculture.

OTA wishes to thank those individuals in the Federal agencies who helped the OTA staff identify existing biological databases, and the advisory panel and numerous other individuals who provided helpful reviews of the document. In particular, OTA wishes to acknowledge the contribution of the Congressional Research Service in providing a synthesis of Federal legislation to conduct biological inventories. As with all OTA reports, however, the content is the sole responsibility of OTA.

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Chapter 1
Introduction

Chapter 1
Introduction

BACKGROUND

Human welfare is inextricably linked to, and dependent on, biological diversity.[1] Not only does the human species rely on other organisms to provide essential sustenance and products that enhance the quality of life (e.g., food and fiber), but the interactions among species affect essential processes (e.g., nutrient cycling) without which the human species could not survive. Concern about biological diversity also has an ethical aspect, deriving from the notion that the human species should avoid causing the extinction of other species that share the planet.

Understanding the components of biological systems and how these components interact is crucial for developing an effective strategy to maintain biological diversity on-site, that is, within the environment where it occurs naturally. A first step in developing such understanding is to document the various components—species, communities, and ecosystems. Once acquired, data about the components can be manipulated to provide information on how best to address concerns about maintaining biological diversity. To be effective in meeting these objectives, however, the acquisition, dissemination, and use of data must be defined within the context of clearly defined goals. Accumulation of biological data should not be considered an end in itself but should be considered a means for achieving various ends, such as maintaining biological diversity.

Over the past two decades, increased interest in natural resources and concerns about environmental quality have produced a deluge of information on the biota of the United States. Proliferation of such data at Federal agencies reflects the growth in stewardship responsibilities the agencies have been given for maintaining the Nation's biological resources, particularly on federally owned lands. State and private institutions also have been generating increasing amounts of information on U.S. flora and fauna.

Data acquisition, for the most part, has been prompted by narrow sets of objectives defined within the contexts of the operational responsibilities of the various agencies and institutions acquiring the data. Not surprisingly, these data are widely scattered and generally incompatible with each other. Information about the existence of data seldom seems to be communicated to potential users of the data. Moreover, maintaining biological diversity has been, at best, only a tangential consideration in most data collection efforts. Consequently, it is difficult, if not impossible, to develop a comprehensive assessment of biological diversity based on the vast amount of data that currently exists.

In response to congressional needs, the Office of Technology Assessment has produced this background paper in support of a broader study, which will identify available and emerging technologies to maintain biological diversity. This paper briefly assesses the state of existing biological data and proposes ways to improve the use of such data for the purpose of maintaining biological diversity. Because of the large amount of data available and the number of institutions involved, the scope of this paper is limited *primarily* to Federal agencies and to data generated from field studies by Federal agency personnel.

This document does not address many collections of biological resources that exist in the Smithsonian Institution and other museums, in U.S. Department of Agriculture facilities, and in universities, private research centers, and other institutions. Although bibliographic information systems serve an important function by providing centralized locations for obtaining information on sources of inventory, monitoring, and baseline biological data, this document does not cover bibliographic databases.

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[1] Biological diversity refers to the variety and variability within and among living organisms and the ecological complexes in which they occur.

THE USES OF BIOLOGICAL DATA IN MAINTAINING BIOLOGICAL DIVERSITY

Maintaining the continuing diversity of plants and animals is a large and complex task, which requires the acquisition, storage, retrieval, and manipulation of enormous quantities of biological data. Biological data consist of information that can indicate the abundance, condition, and distribution of species, communities, and ecosystems. These data can reveal the status of the biological diversity and disclose any changes that may be taking place, and the data can be used to develop effective plans for managing resources. To ensure the continued health of the natural biota the data can be used to provide a baseline from which to monitor the effectiveness of a plan once it is implemented.

For Determining Status and Trends

The status or number and kinds of organisms within a given area can be obtained through field inventories. This information serves as a starting point, or baseline, from which to measure changes that occur and from which to determine the effects of various activities, such as timber harvesting, on the biological diversity of an area. Similarly, data collected in one geographic area can be compared with data collected (using similar methods) from other areas to evaluate spatial differences in biological diversity.

Data also allow the assessment of trends, which are changes in distribution and abundance or in rates of change that occur over time. For example, the Fish and Wildlife Service (FWS) reports that approximately 400,000 acres of wetland habitat are altered or lost each year (11). The rate of alteration has been established by comparing aerial photos of a statistical sample of wetland areas taken during the 1950s with photos of the same areas taken during the 1970s.

Data on the status and trends of biological data can help decisionmakers to identify species, populations, or habitats that may need protection. FWS, for example, evaluates the current status of species and subspecies and how their populations have changed over time in order to identify candidates for listing as threatened or endangered species or for recovery efforts under the Federal Endangered Species Act (Public Law 93-205, as amended). State agencies responsible for State laws that protect endangered species carry out similar evaluations.

For Planning and Management

Planning and management efforts to maintain biological diversity can take many forms, but all of them require reliable information on biological resources. Data on the abundance and variety of species or ecosystems can be used to establish priorities for land acquisition or designation. Congressional acquisition of National Park Service (NPS) land, for example, is based on available information about nationally significant esthetic, biological, or cultural resources and about the potential threats to those resources. The Bureau of Land Management's (BLM) designations of Areas of Critical Environmental Concern are supported by evidence of the areas' unique biological or cultural resources.

In determining the size and shape of an area required to protect a particular species or habitat, it is necessary to gather various kinds of information including habitat requirements, the existing population size, the available food and cover, and the population's migration habits. Such data are used to determine the minimum size of the area and the minimum number of individuals required to sustain healthy populations or species. The U.S. Forest Service (FS) and other agencies, for example, undertook extensive studies of the northern spotted owls on national forest lands in the Pacific Northwest to establish the minimum area needed for a breeding pair of owls. By tracking the owls' use of their habitat and by noting the seasonal changes in that use, the agencies were able to determine how much land was used for feeding and nesting by a breeding pair. The data generated in this project are helping resource managers to identify the minimum population size and protected habitat needed to conserve viable breeding populations of spotted owls in national forests (8).

Baseline biological data also feed into the development of plans for habitat or ecosystem management. In general, an area is surveyed to identify its resources, and a plan is devised to create the best possible habitat conditions for the chosen plant or animal species or type of ecosystem. To prepare the Burro Creek Riparian Management Plan in west central Arizona, for example, the BLM conducted intensive inventories of the area's flora and fauna between 1977 and 1982. The biota inventoried included the following: birds (3,6); amphibians and reptiles (4); mammals (7,10); fish (5); and vegetation (2,9). Data from these inventories were used to identify the status of the resources and to identify management options for maintaining the habitats in the area as well as for restoring degraded habitats.

In developing management plans for a wide geographic area that contains different habitats, such as a national forest, data are needed on each kind of habitat in the area. The capability of the land or water to support economic activities (e.g., timber harvesting) and recreational opportunities as well as to maintain biological resources must be considered. Decisionmakers determine the best uses of each area and devise appropriate management options. Without some baseline measure of the available resources, and without data on what the land and water can support, the consequences of particular courses of action are likely to be projected inaccurately.

Finally, species recovery efforts, such as those conducted by the Federal Office of Endangered Species of the FWS, require extensive information about the endangered or threatened species or subspecies. Data on habitat affinities, interspecies interactions, dietary habits, and reproductive needs, all must be analyzed if the efforts are to be effective (12).

For Monitoring

Once a management strategy is implemented, data are needed to monitor its effectiveness. Successful monitoring of resources depends on obtaining sound information about the status of a species, habitat, or ecosystem prior to application of the plan. Data showing how the status of the resources has changed over time help decisionmakers evaluate their past decisions. Previously unidentified changes in an area's biological diversity can lead to alteration of management strategies or reconsideration of the need to acquire or designate land for protection. For example, the National Marine Fisheries Service (NMFS) Alaska and Northwest Fisheries Center maintains a database on more than 2,400 species or species assemblages within its jurisdiction (RACE Ground Fish Data Base). The data, collected over time, indicate trends in abundance and distribution of these organisms so NMFS can monitor changes. The monitoring data can then be used to determine how commercial harvesting affects species' populations. This, in turn, may lead to alterations in fishing guidelines (1).

The following discussion begins with an assessment of the institutional mechanisms that promote biological data collection. Existing Federal biological databases and gaps in the available information regarding biological diversity are examined. And the technological opportunities to facilitate biological data collection, storage, and retrieval are briefly described. The paper provides an assessment of factors that constrain or enhance opportunities for collecting biological data and concludes with a discussion of several avenues to improve the data collection efforts for maintaining biological diversity.

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Chapter 2

Institutional Aspects of Biological Data

Chapter 2

Institutional Aspects of Biological Data

HIGHLIGHTS

- Numerous Federal laws and policies require or permit Federal agencies to conduct inventories of natural resources, although few of the inventories directly address on-site maintenance of biological diversity.
- Federal agency objectives, differing interpretations of mandates, and lack of specificity in Federal mandates calling for biological data lead to problems of data incompatibility and data inconsistency within and among Federal agencies.
- In contrast to Federal agencies, some State and private institutions consider biological diversity as one objective in their biological field inventories.

FEDERAL AUTHORITIES

Federal laws and policies regarding conservation abound, causing numerous Federal agencies in different locations to generate massive amounts of data, much of which may be applicable to efforts to maintain biological diversity on-site. Table 1 describes the Federal laws that mention biological inventories. More than 14 Federal agencies in at least 4 different departments[1] are identified in mandates to conduct inventories of natural resources. Some mandates call for inventories of resources within a specific geographic area, a regional area, or the Nation as a whole. Other laws authorize inventories of specific species or broad ranges of organisms or ecosystems.[2]

The table distinguishes between laws that permit inventories and those that require biological inventories. (See the column labeled "Level of requirement.") Laws *permitting* inventories generally provide the legislative authority for agencies to conduct research on biological resources. An example of such a law is the Anadromous Fish Conservation Act (3). The laws that *require* inventories may direct agencies to conduct inventories, or may indirectly require agencies to conduct inventories because of the need for biological information to carry out the intent of the laws (3). The Migratory Bird Treaty Act is an example of the indirect type of requirement.

Policies and agency directives may stimulate as much data collection as Federal mandates. An agency or department may state the need for biological data in regulations or departmental programs that address broader environmental goals. Such regulations and programs may clarify Federal legislation or may occur independently.[3] For example, the National Park Service (NPS) completed an extensive inventory of ecosystems in the United States as one result of a 1965 directive from the Secretary

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[1] Within the executive branch of the Federal Government, departments have broad areas of Federal responsibility. Agencies may be created within a particular department to address relatively specific responsibilities within the department's jurisdiction.

[2] Federal laws reflected in table 1 do not include legislation that requires inventories in one specific regional area (e.g., the Columbia River watershed) or one State (e.g., Tennessee).

[3] Many agency and departmental policies and regulations calling for biological inventories are linked to the mandate for environmental assessments in the National Environmental Policy Act (NEPA; Public Law 91-190). Although NEPA does not require inventories to be conducted specifically, the agency regulations promulgated as a result of NEPA may do so. Environmental impact assessments conducted as a result of NEPA have stimulated the collection and analysis of biological data for thousands of Federal projects.

Table 1.—Federal Laws Authorizing Biological Inventories

Resource/taxon	Lead agency	Conservation program	Popular name of law	Public Law[a]	U.S. Code[a]	Date enacted	Level of requirement[b]
Department of the Interior:							
Irrigated Indian lands	BIA	Research on irrigation of Indian lands		Ch. 119	25 U.S.C. 381-390	1887	P
Indian forest lands	BIA	Research to manage reservation timber for sustained yield		Ch. 431	25 U.S.C. 406-407; 466	1910	P
Wild horses and burros	BLM	Survey of horses and burros on public lands	Wild Free-Roaming Horses and Burros Act	95-514	16 U.S.C. 1333(b)	1978	R
Resources of public lands	BLM	Inventory of public lands BLM and their resources	Federal Land Policy and Management Act	94-579	43 U.S.C. 1711	1976	R
Rangelands	BLM/FS	Inventory of rangeland conditions and trends	Public Rangelands Improvement Act	95-514	43 U.S.C. 1903	1978	R
Animals	FWS	Inventory by States of nongame fish and wildlife	Fish and Wildlife Conservation Act	96-366	16 U.S.C. 2003	1980	P
Animals	FWS	Surveys of animals on land and water in public domain	Fish and Wildlife Coordination Act	Ch. 55	16 U.S.C. 661 et seq.	1934	R
Animals	FWS	Cooperative grants to States for restoration of fish and wildlife	Pittman-Robertson Wildlife Restoration Act	Ch. 899	16 U.S.C. 669 et seq.	1937	P
Animals	FWS	Reports on availability and requirements of fish and wildlife	Fish and Wildlife Act of 1956	Ch. 1036	16 U.S.C. 742d	1956	R
Migratory birds	FWS	Requires regulation of hunting according to bird surveys	Migratory Bird Treaty Act	Ch. 128	16 U.S.C. 704	1918	R
Fisheries	FWS	National Fisheries Center and Aquarium/fisheries research		87-758	16 U.S.C. 1051 et seq.	1962	P
Estuarine areas	FWS	Inventory of marshes, lagoons, estuaries, including Great Lakes		90-454	16 U.S.C. 1221-1226	1968	R
Commercial fisheries	FWS/NMFS	Reports on fish populations and their diseases		Ch. 362	16 U.S.C. 744	1887	R
Endangered species	FWS/NMFS	Federal studies to determine species at risk	Endangered Species Act	93-205	16 U.S.C. 1533	1973	R
Endangered species	FWS/NMFS	Federal/State cooperative studies	Endangered Species Act	93-205	16 U.S.C. 1535	1973	R
Outer Continental Shelf (OCS)	MMS	Collection of baseline data in areas proposed for OCS oil and gas leasing	Outer Continental Shelf Lands Act	92-372	43 U.S.C. 1346	1978	R
Rivers	NPS/FWS/BLM/FS	Inventory of rivers with potential for designation as wild or scenic	Wild and Scenic Rivers Act	90-542	16 U.S.C. 1275	1986	P
Department of Commerce:							
Pacific coral reefs	NOAA/SI	Studies on reefs and *Acanthaster planci* starfish		91-427	16 U.S.C. 1211-1213	1970	P
Marine sanctuaries	NOAA	Research on marine sanctuaries		96-332	16 U.S.C. 1432(f)	1980	P
Marine mammals	NMFS/FWS	Research grants on protection of marine mammals	Marine Mammal Protection Act	92-522	16 U.S.C. 1380	1972	P
Anadromous and NMFS Great Lakes Fisheries	NMFS	Investigation and biological surveys of anadromous and Great Lakes fish	Anadromous Fish Conservation Act	89-309	16 U.S.C. 757b	1965	P
Pacific Ocean fisheries	NMFS	Study fish populations of Pacific to ensure resource development		Ch. 451	16 U.S.C. 758a	1960	R
Northern Pacific fur seals	NMFS	Research on Northern Pacific fur seals	Fur Seal Act	89-702	16 U.S.C. 1153	1966	P
Northern Pacific fur seals	NMFS	Studies of fur seal populations and trends	Marine Mammal Protection Act	92-522	16 U.S.C. 1378	1972	R
Whales	NMFS	Studies of biology of whales in U.S. waters	Whale Conservation and Protection Study Act	94-532	16 U.S.C. 917a	1976	R
Fisheries	NMFS	Research on abundance and availability of fish	Magnuson Fishery Conservation and Management Act	94-265	16 U.S.C. 1854(e)	1976	P

Table 1.—Federal Laws Authorizing Biological Inventories—Continued

Resource/taxon	Lead agency	Conservation program	Popular name of law	Public Law[a]	U.S. Code[a]	Date enacted	Level of requirement[b]
Department of Defense:							
Animals and plants	DOD/FWS	Planning for wildlife, fish, and plants on military reservations	Sikes Act	86-797	16 U.S.C. 670a	1960	P
Environmental Protection Agency:							
Water quality	EPA	Studies of effects of water quality on biota	Clean Water Act	92-500	33 U.S.C. 1254	1972	R
Air quality	EPA	Studies of effects of air quality on biota	Clean Air Act	88-206	42 U.S.C. 7403	1963	R
Pesticide exposure	EPA	Monitoring of soil, water, plants, and animals for pesticide exposure	Federal Insecticide, Fungicide, and Rodenticide Act	92-516	7 U.S.C. 136r	1972	R
Department of Agriculture:							
Forests	FS	Cooperative forestry research by State land grant colleges	McIntire-Stennis Act	87-788	16 U.S.C. 582a	1962	P
Renewable resources	FS	Inventory of lands and renewable resources of National Forests	Forest and Rangeland Renewable Resources Planning Act	93-378	16 U.S.C. 1603	1974	R
Renewable resources	FS	Comprehensive research on renewable resources of forests and rangeland	Forest and Rangeland Renewable Resources Research Act	95-307	16 U.S.C. 1642	1978	R
Plants	NA	Research on tree and plant life		Ch. 505	20 U.S.C. 191-195	1927	R
Soil	SCS	Inventory of soil quality and related resources	Soil and Water Resources Conservation Act	95-192	16 U.S.C. 2004	1977	R
Smithsonian Institution:							
Biota	SI	Increase diffusion of knowledge		Ch. 69	20 U.S.C. 41	1877	P
Biota of former Canal Zone	STRI	Scientific investigation of natural features of former Canal Zone		Ch. 516	20 U.S.C. 79a	1940	R

[a] Code Citations: The citations to the U.S. Code reflect the smallest relevant portion of the code that directed such studies—single sections, where possible. The Public Law citations are to the first laws to enact the particular provisions. The reference should be understood to include the act and any subsequent amendments. No attempt was made to cite the original laws creating the overall chapters or subchapters where the sections of interest were added only in later amendments.

[b] Level of requirement:
P = Inventories permitted
R = Inventories required.

SOURCE: Congressional Research Service, 1985.

of the Interior to develop the National Natural Landmark Program (4). Concern over wetland ecosystems prompted the U.S. Fish and Wildlife Service (FWS) to initiate an ongoing inventory of wetland areas in the United States, independent of a specific congressional directive. (See National Wetlands Inventory in app. A.)

The primary Federal agencies collecting information on biological resources are those concerned with managing land and resources. These agencies include:

- U.S. Department of the Interior
  - —Bureau of Land Management
  - —National Park Service
  - —Fish and Wildlife Service
- U.S. Department of Agriculture
  - —Forest Service
  - —Soil Conservation Service
- U.S. Department of Commerce
  - —National Oceanic and Atmospheric Administration
    - —National Marine Fisheries Service.

Other agencies that collect biological data include the Environmental Protection Agency, the Bureau of Indian Affairs, the armed forces agencies in the Department of Defense, the U.S. Geological Survey, and the Smithsonian Institution. Each agency has a specific mandate or a program directive to conduct inventories of biological resources within its jurisdiction. Agencies also have regulatory responsibility over actions that could affect the maintenance of the diversity of biological resources under their stewardship. Federal agencies that collect data on biological resources are presented in table 2.

On-site maintenance of biological diversity is rarely considered in Federal legislation specifically requiring inventories of resources (3). The mandates appear to address diversity maintenance indirectly in relation to the conservation of natural resources (which include biological resources, soils, water, and air). For example, the Soil and Water Resources Conservation Act reauthorized the Soil Conservation Service to conduct national inventories, which are now known as the National Resources Inventories (NRI). Maintaining biological diversity is not a stated objective in their mandate, but the inventories provide baseline information on a wide range of natural resources, including some of the Nation's biological resources. (See NRI in app. A.) NRI data could be used to identify areas around the country where planning and management programs are needed to maintain biological diversity.

Although it does not mention biological diversity maintenance as a specific objective, the Endangered Species Act (ESA) mandates the analysis of data on species that are threatened or endangered, or potentially threatened or endangered. In response to the ESA, Federal agencies concerned with resource and land management collect and maintain data on the distribution and abundance of the endangered species that fall within the agencies' jurisdictions. These data can be used directly to determine the status and location of biological diversity and provide information necessary to maintain adequate diversity. The available data also assist agencies in efficiently and professionally carrying out their responsibilities for conserving resources.

An agency's response to a given mandate or policy for a biological inventory depends, in part, on the specifications included for the data. Few Federal agencies consolidate resource data nationally, unless specific direction is provided by Congress or in a policy, because data coordination is considered time-consuming, and because large volumes of data are costly to maintain. Additionally, many Federal resource agencies have decentralized their internal decisionmaking processes. Field offices or regional offices are given authority for collecting data and for managing the resources under local jurisdiction. Consequently, many inventories are decentralized, reflecting the organizational structures of the Federal agencies, and national aggregation of data may be of little use to field offices.

Consolidating or even analyzing data from disparate sources is difficult at present, because standardized definitions are lacking, because different agencies have different objec-

Table 2.—Federal Agencies With Resource Information and Data-Gathering Programs by Resource Type

	NPS	BIA	DOD	SCS	FWS	FS	BLM	NOAA	EPA	Corps
Wildlife:										
Wildlife habitat		X	X	X	X	X	X	X		
Migratory birds					X					
Anadromous fish					X			X		
Freshwater fish	X		X		X	X		X		
Endangered species	X	X	X	X	X	X	X	X	X	X
Pesticide monitoring					X				X	
Marine birds					X		X		X	
Vegetation:										
Forest	X	X	X	X	X	X	X	X		
Rangelands		X	X	X	X	X	X			
Aquatic					X			X	X	X
Riparian	X				X	X	X			
Wetlands				X	X	X	X		X	X

KEY: NPS—National Park Service; BIA—Bureau of Indian Affairs; DOD—Department of Defense; SCS—Soil Conservation Service; FWS—Fish and Wildlife Service; FS—Forest Service; BLM—Bureau of Land Management; NOAA—National Oceanic and Atmospheric Administration; EPA—Environmental Protection Agency; and Corps—Corps of Engineers.

SOURCE: Adapted from Council on Environmental Quality, 1980; and Appendix A.

tives, and because data collection efforts either overlap or are duplicative. Confusion exists over the meanings of terms such as *wildlife, fish and wildlife, biological resources,* and *natural resources. Wildlife,* for instance, may be interpreted legislatively in several different ways, including:

- mammals that are hunted or trapped (game);
- mammals generally, the word *animal* also is sometimes used in this way;
- those animals, whether vertebrates or invertebrates, that are not fish—a usage that has no technical or biological equivalent;
- vertebrates; and
- both vertebrates and invertebrates (3).

Because of disparate definitions of wildlife, two agencies mandated to inventory wildlife may collect data on different subsets of the resource. For example, one agency might inventory game mammals, and the other might collect data on all resident terrestrial vertebrates and invertebrates. Interpretation of what kind of biological data to collect can vary within an agency, as well.

In addition to defining terms differently, agencies have different objectives for biological inventories and consequently collect different kinds of data. The kinds of data collected usually reflect the missions of the agencies. For example, although both the National Oceanic and Atmospheric Administration (NOAA) and the Bureau of Land Management (BLM) have authority to inventory fishes, NOAA might conduct inventories of commercially harvested fish species for economic forecasting in the fishing industry, whereas BLM might conduct inventories of the nongame fish populations the agency is directed to manage and sustain. Generally, the authority to conduct an inventory does not clearly define what resources the data collection should address.

An inventory, itself, may be incidental to a broad mandate within an agency. This is the case with the migratory bird inventories conducted under the authority of the Migratory Bird Treaty Act. The act directs FWS to manage migratory bird populations and regulate harvesting of selected species. In order to accomplish the objectives of this mandate, FWS maintains large volumes of data for tracking population trends.

Finally, mandates and policies to conduct inventories of biological resources may overlap other mandates within an agency or among agencies. Data collection in the coastal zone is a case in point. Apparently, NOAA, FWS, and NPS each have authority to conduct coastal resource inventories. Federal data collection in the coastal zone may be duplicative, or it may overlap State efforts to inventory and manage coastal resources.

STATE AND PRIVATE INSTITUTIONS

State agencies concerned with managing land or natural resources are authorized to conduct resource inventories under mandates and policies similar to Federal legislation. Such agencies include State fish and game departments, wildlife departments, forestry agencies, and others. Like Federal agencies, few State agencies are instructed to collect data that are directly applicable to the maintenance of biological diversity. Although most biological inventories do not consider biological diversity maintenance, exceptions include State natural history surveys, State heritage programs, and similar efforts.

A recent survey[4] of State natural resources programs indicated that the responding States collected biological data, but that the responsibilities for data generation and maintenance tended to be scattered and uncoordinated among agencies. Natural history surveys within some States represent efforts to consolidate biological and natural resource information in centralized locations. Formally authorized surveys of State biota exist in Kansas, Illinois, Montana, Oklahoma, Nevada, New York, North Carolina, and Wisconsin. These surveys were mandated to collect and synthesize biological data and, in some cases, maintain voucher specimens, but the completeness of the surveys varies widely. Montana's Natural Resource Information System, authorized in 1983, has not been funded, and Wisconsin's biological data has not been updated for more than 40 years. Illinois' Natural History Survey, however, has been active for more than 100 years and maintains a large collection of biological data.

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[4] An informal survey of State agencies was conducted by the Librarian of the Illinois Natural History Survey. The results from the letters sent to the States are unpublished and uncompiled.

States without formal natural history surveys generally have authority to collect data on game fish and wildlife, and on land cover (e.g., forests, croplands, rangelands). Recent interest in nongame species and rare plants led to new authorizations in most States for research and inventories on nongame species, as well.[5]

A cooperative State and Federal effort began a few years ago to consolidate information on fish, mammals, birds, and selected invertebrates into statewide databases whose formats were consistent among the States. These State biological information systems, known as State Fish and Wildlife Information Systems or "Procedures" databases, are operating in 10 States to help State agencies organize and manage fish and wildlife information, and to provide a consistent source of information for Federal agencies concerned with how particular projects will affect fish and wildlife resources (1).

No discussion of institutions conducting biological inventories would be complete without highlighting the State Natural Heritage Programs and The Nature Conservancy (TNC). Each of the approximately 43 existing Natural Heritage Programs conducts or consolidates inventories of existing biological data to identify the occurrence of organisms or species assemblages that are rare, threatened, endangered, or locally endemic. The Natural Heritage Programs assimilate biological data with the express purpose of using it to maintain biological diversity. Heritage programs may be operated in one of three ways: 1) solely by the State, 2) under cooperative agreement between TNC and the State, or 3) solely by TNC.

Natural Heritage Programs make important contributions to State and Federal agencies involved in protecting threatened and endangered species—which means protecting species diversity. The programs provide data to identify land or water areas that need protection to maintain diversity. Although data quantity and quality vary from State to State, data generated at the State level are collated and summarized at the national level by TNC to provide information on biological diversity across the country. In many geographic areas, TNC is the only institution collecting data on rare, sensitive, or endemic resources that may require special management considerations to maintain their integrity as populations. In these areas, TNC efforts help to fill an important gap in biological data needed for the on-site maintenance of biological diversity.

In addition to TNC heritage programs, numerous small, nonprofit organizations collect data on biological resources. Groups like the land-preservation trusts conduct inventories of the lands under their stewardship; and species-protection organizations, such as the World Pheasant Organization, collate data for specific taxonomic groups.[6] A survey of all data generated by these organizations and biological research data generated by universities would be an impossible task.

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[5] The following States have enacted legislation to fund nongame fish and wildlife programs: Alabama, Arizona, Arkansas, California, Colorado, Delaware, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Montana, Nebraska, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Utah, Virginia, West Virginia, Wisconsin (2).

[6] See OTA's background paper, *Grassroots Conservation of Biological Diversity in the United States*, prepared in support of a forthcoming OTA assessment on *Technologies To Maintain Biological Diversity*.

In summary, biological data are collected, collated, or synthesized by most institutions with responsibilities for, or interests in, conserving biological resources. Little effort is made to consolidate the vast amounts of data generated by these institutions.

CHAPTER 2 REFERENCES

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Chapter 3

Existing Biological Databases

Chapter 3

Existing Biological Databases

HIGHLIGHTS

- **No national inventory of biological resources exists, and national databases cannot be easily consolidated into a comprehensive biological database because of incompatibilities in definitions, terminology, and data collection efforts.**
- **Steps have been taken to begin formulating standards for biological data and to increase the coordination of Federal activities related to collecting and maintaining biological data.**

OVERVIEW

Data on biological resources are abundant and varied because of the different objectives perceived within each agency and the number of agencies collecting data. A 1977 survey of ecological monitoring activities indicated that the Federal Government had at least 1,600 monitoring projects underway (12). Many of these efforts have generated data and, hence, created the need for databases. The databases discussed in this section are primarily those field-collected biological data maintained by Federal agencies.

A Federal resource agency's responsibilities for biological conservation are reflected in the kind of data and database most useful to the agency or the data users. The objectives and responsibilities of the resource scientists and managers dictate the kinds of databases created and maintained. Scientists interested in mapping ecotypes, for example, would not be interested in maintaining data on nutrient cycling within each ecotype as part of the databases. Scientists attempting to manage animal populations for maximum production of offspring, however, might require databases containing very specific information on reproduction and genetic characteristics of individuals within the populations.

Few Federal biological databases are created or designed specifically to measure biological diversity, partly due to the lack of congressional or administrative direction to consider biological diversity in data collection. Notable exceptions exist, however. For example, the Wildlife Habitat Relationships Programs[1] developed by the Forest Service (FS) are designed to help biologists maintain terrestrial vertebrate diversity in National Forests. The endangered species files maintained by numerous Federal land-managing agencies also aid efforts to reduce the loss of biological diversity on lands or in waters under the agencies' stewardship. The Fish and Wildlife Service (FWS) maintains a "candidate species list" and The Nature Conservancy (TNC) maintains a database on the location of Research Natural Areas found on Federal, State, and private lands. These databases help Federal employees identify specific aspects of diversity that could be considered in on-site resource planning and management. In the future, the Endangered Species Information System (see app. A) will provide information and management guidelines to a number of Federal agencies working to conserve endangered species and their habitats.

Generally, biological databases incorporate wide arrays of information on organisms, populations, species, habitats, or ecosystems. Data on an organism or population range from a scientific name (genus and species) to a full complement of life history information (e.g., age, sex, behavior, food habits, and habitat affiliations and uses). Databases devoted to species may simply include physical characteristics or may contain detailed information on local populations or even individual behaviors. Databases focused on habitats and ecosystems include specific information on the species that are present and their interactions or simply provide the locations of the ecosystems or habitats.

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[1] This database and others can be found in app. A.

Biological data are the least standardized forms of natural resource information (9). Although collectors of data on water and the atmosphere appear to have adopted standardized names and units of measure, collectors of biological data have few standards for data terminology, measures, or even names of given organisms. In many cases, different standards exist within individual Federal agencies. For example, each of the 33 ecosystem identification surveys conducted under the National Park Service (NPS) in its National Natural Heritage Program was based on a different land classification system (11). The result is incompatibility in the terms used to identify ecosystems within the different regions.

Another factor contributing to the incompatibility of databases is the goal-oriented nature of data collection. Data generated in surveys and monitoring projects tend to be site-specific and designed to meet single goals. Because of this narrow goal orientation, little consideration is given to standardized formats or potential compatibility with other systems, and little effort is made to apply existing data to other uses, although the range of applicability may be wide. These factors limit the ability to consolidate data to provide information about wide geographic areas.

EXISTING DATABASES

Appendix A lists Federal databases containing biological data. Most of the databases were created in the past 5 to 7 years. The list provides a general description of each database, including the content, purpose, geographic coverage, taxonomic coverage, status, users of the data, and a contact person (if known or available). The list is not a comprehensive survey of Federal databases, but it provides examples of the kinds of biological data that Federal agencies collect or maintain. Table 3 is a summary of appendix A.

Geographic Coverage

The list in table 3 is biased towards databases of regional or national coverage. (See discussion of methodology in app. A.) Databases with national coverage are specific to single biological resources or to a few resources (e.g., FWS' National Wetland Inventory; see app. A), or provide only cursory information on a broad range of resources (e.g., the National Resources Inventory compiled by the Soil Conservation Service). No national inventory of biological resources exists.

In addition, databases listed as national or regional generally do not cover all land areas of the United States. The Forest Inventory conducted by the FS is national in scope but does not cover all land area in the United States. Similarly, although NPS' Endangered Species Data Base (see app. A) will be national in coverage, it is restricted to NPS lands.

Regional databases appear to contain greater detail than national databases. For example, the FWS regional databases provide specific data on several selected fish or bird species, whereas the national databases contain more generic information on a wide range of organisms. Similarly, the regional FS wildlife databases (see app. A) contain more specific information on wildlife species than the national Resources Planning Act Wildlife Data Base (see app. A).

Geographic gaps in biological databases are not readily apparent, judging from the infor-

Table 3.—Taxonomic Coverage of Federal Agency Databases (summary of app. A)

Database	Vegetation	Trees	Mammals	Birds	Amphibians/ reptiles	Aquatic animals
U.S. DEPARTMENT OF THE INTERIOR						
National Park Service						
National databases:						
NPFLORA	X	X	...	...	...	...
Nationwide Rivers Inventory	X	X	X	...	...	X
Natural Landmarks Program	X	X	X	X	...	X
Endangered Species Data Base	X	...	X	X	X	X
COMMON	...	...	...	...	...	...
Regional databases:						
Coastal Barriers Inventory	...	...	...	...	...	...
North Atlantic Region Resource Data	X	X	...	...	...	...
State/sub-State databases:						
Wild and Scenic Rivers	X	X	...	...	...	X
Biosphere Reserve Data Files	X	X	X	X	X	X
Bear Information System, Yellowstone	...	...	X	...	...	...
Ground Cover System	X	X	...	...	...	...
Vegetation Data, Great Smoky Mountains National Park	X	X	...	...	...	...
Channel Islands Information System	X	...	X	X	X	X
Bureau of Land Management						
Regional databases:						
Range Site Inventory	X	X	...	...	...	...
SVIM	X	X	...	...	...	...
IHICS	X	X	X	X	X	X
RAIDS	X	X	...	...	...	X
Wild Horse and Burro Inventories	...	...	X	...	...	...
State/sub-State databases:						
Extensive Forest Inventory	X	X	...	...	...	...
Forest Operations Inventory	X	X	...	...	...	...
TPCC	...	X	...	...	...	...
STORMS	...	X	...	...	...	...
Wilderness Inventory	X	X	X	X	...	X
Fire Management Data	X	X	...	...	...	...
Threatened and Endangered Species Data Bases	X	X	X	X	X	X
U.S. Fish and Wildlife Service						
National databases:						
Winter Waterfowl Survey	...	...	...	X	...	...
North American Breeding Bird Survey	...	...	...	X	...	...
Mourning Dove Call-Count Survey	...	...	...	X	...	...
River Reach Fish Data Base	...	...	...	...	...	X
Wildlife Refuge Management Information System	X	...	X	X	X	X
National Wetlands Inventory	X	X	X	X	X	X
Wetland Plant Species Data	X	X	...	...	...	...
Endangered Species Information System	X	X	X	X	X	X
Candidate Species List	X	...	X	X	X	X
Habitat Suitability Index Models	...	...	X	X	X	X
Fish and Wildlife Reference Service	...	...	X	X	X	X
Regional databases:						
Waterfowl Breeding Ground Surveys	...	...	...	X	...	...
Woodcock Singing Ground Survey	...	...	...	X	...	...
Sandhill Crane Surveys	...	...	...	X	...	...
Great Lakes Commercial Catch Data	...	...	...	...	...	X
Great Lakes Research Fish Data	...	...	...	...	...	X
FISHNET	...	...	...	...	...	X
Coastal and Marine Bird Data Base	...	...	...	X	...	...
Coastal Area Characterization Studies	X	...	X	X	X	X
Coastal Ecological Inventory	X	...	X	X	X	X
Coastal and Estuarine Species Profiles	...	...	X	X	X	X

Table 3.—Taxonomic Coverage of Federal Agency Databases (summary of app. A)—Continued

Database	Vegetation	Trees	Mammals	Birds	Amphibians/ reptiles	Aquatic animals
Marine and Waterbird Colony Data	...	...	...	X	...	...
Threatened and Endangered Species Sighting List	...	...	X	X	...	...
Plant Information Network	X	X	...	...	...	...
RAPTOR	...	...	...	X	...	...
Terrestrial Species Data Base	...	...	...	X	...	...
U.S. Geological Survey						
National database:						
Land Use/Land Cover	X	X	...	...	...	...
Regional database:						
Coastal Ecological Inventory	X	X	X	X	X	X
U.S. DEPARTMENT OF AGRICULTURE						
Soil Conservation Service						
National databases:						
NRI	X	X	...	...	...	...
National Forest-Soil Data Base	X	X	...	...	...	...
National Range Data Base	X	...	...	...	...	...
Regional database:						
New England Animal Species Data	...	...	X	X	X	...
U.S. Forest Service						
National databases:						
Forest Inventory and Analysis	X	X	...	...	...	...
Range Analysis	X	X	...	...	...	...
FSRAMIS	X	X	...	...	...	...
RPA Range Data	X	X	...	...	...	...
Research Natural Areas	X	X	...	...	...	...
RPA Wildlife Data	X	X	X	X	X	X
Regional databases:						
RUNWILD	...	...	X	X	X	X
WILDHAB	...	...	X	X	X	X
RARE Phase II	X	X	X	X	...	X
State/sub-State databases:						
Inventory Data for Timber Management Planning	X	X	...	...	...	...
Fuels Inventory	X	X	...	...	...	...
Timber Stand Analysis and Silviculture Presciption	X	X	...	...	...	...
Western Sierra WHR Program	...	...	X	X	X	...
North Coast Cascades WHR Program	...	...	X	X	X	...
North East Interior WHR Program	...	...	X	X	X	...
Southern California WHR Program	...	...	X	X	X	...
U.S. DEPARTMENT OF COMMERCE/NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION						
National Ocean Service						
Regional databases:						
Marine Living Resource Data	...	...	X	X	X	X
National Estuarine Inventory	...	...	X	X	X	X
National Marine Fisheries Service						
Regional databases:						
Fisheries Statistics Data Base	...	...	...	...	...	X
Marine Recreational Fishery Statistics	...	...	...	...	...	X
Bowhead Whale Census	...	...	X	...	...	...
Icthyoplankton Survey Data Base	...	...	...	...	...	...
RACE Ground Fish Data Base	...	...	...	...	...	X
State/sub-State database:						
Northern Fur Seal Study	...	...	X	...	...	...

Table 3.—Taxonomic Coverage of Federal Agency Databases (summary of app. A)—Continued

Database	Vegetation	Trees	Mammals	Birds	Amphibians/ reptiles	Aquatic animals
National Environmental Satellite, Data and Information Service						
National Environmental Data Center	X	...	X	X	X	X
MISCELLANEOUS AGENCIES						
U.S. Army Corps of Engineers						
Benthic Resource Assessment	...	...	...	...	...	X

SOURCE: Office of Technology Assessment, 1986.

mation in appendix A. Identification of specific geographic gaps would require consolidation of known databases on different biota. In some cases, gaps within databases are not widely recognized because of limits in mapping or tabulating capabilities. Alternatively, gaps in regional or national databases may be known only to the individual data collectors within a specific geographic area, as is the case with the Bureau of Land Management's (BLM's) Integrated Habitat Inventory and Classification System (see app. A) (10).

Taxonomic Coverage

Each land management agency listed in appendix A maintains data on vegetation or land cover for lands under its jurisdiction. In addition, the Soil Conservation Service (SCS) and the FS maintain data on land cover on all lands within the contiguous United States. Plants of economic importance (e.g., timber and range species) generally receive the primary attention when vegetation inventories are compiled. Aquatic plant species are inventoried by a number of Federal agencies, including FWS, FS, and the National Ocean Service of the National Oceanic and Atmospheric Administration.

Data on mammals, birds, and fish also are stored by each of the Federal agencies in the list. In some databases, available data cover only species of economic or Federal significance—those species that are commercially harvested, federally listed as threatened or endangered, or protected by international treaty. Other databases, such as the Resource Assessment and Conservation Engineering Ground Fish Data Base compiled by the National Marine Fisheries Service (see app. A), contain data on a number of species.

Taxa that are not as clearly defined as mammals and birds generally receive less attention in biological databases. For example, database coverage of amphibians and reptiles is smaller than that of birds and mammals. Aquatic animals, with the exception of fish, receive even less attention than do amphibians and reptiles. Data on insects (class Insecta) were not available in the databases listed.

The lack of data on insects is the most obvious gap in taxonomic coverage of data collected on-site. The Animal and Plant Health Inspection Service maintains an extensive museum collection of insect species, which may be sufficient to fill apparent gaps in biological knowledge in field inventories (6). However, museum specimens must be identified relative to their native habitats, using a classification system compatible with on-site inventories, if they are to be of use in evaluating onsite diversity.

Aquatic plants currently are receiving considerable attention, but aquatic animals are not. Few Federal agencies inventory and maintain data on aquatic animals other than fish, partly because of the costs of field inventories and identification, and because of the lack of specific mandates to consider these organisms in on-site inventories.

The taxonomic categories used in appendix A are broad, precluding detailed analysis of further taxonomic gaps in biological data coverage. For example, some databases containing data on fish species cover only single species or a few species (e.g., FWS' FISHNET; see app. A) whereas others cover large numbers of species (e.g., FWS' River Reach Fisheries Data Base; see app. A). Data on a taxa may vary by location within a regional or national database, which is the case with BLM's Integrated Habitat Inventory and Classification System (IHICS; see app. A). BLM State and District files included in the IHICS vary considerably in the coverage of mammal, bird, or amphibian and reptile taxa. In the Shoshone District in Idaho, for example, the data predominantly concern game species, whereas the Elko District in Nevada provides comprehensive coverage of vertebrates (10).

Data Overlap

In response to a congressional mandate that threatened and endangered species be considered in agency activities, all Federal agencies maintain data on species that are federally listed as being threatened or endangered. Such data may be duplicative.

Coastal and estuarine resources also are inventoried by a number of Federal agencies. Comprehensive databases have been developed regarding birds, vegetation, habitats, and ecosystems. (See, e.g., the Coastal Ecological Inventory, Marine and Waterbird Colony Data, National Estuarine Inventory in app. A.) Although data vary among these databases, overlap appears to exist for some of the resources. Consolidation of these inventories could provide a comprehensive database of biological diversity in coastal areas.

Defining specific areas of overlap or gaps in biological data coverage would be extremely difficult currently because databases from different sources generally are not consolidated. Agencies and individuals have their own terms, definitions, and scientific names for biological data, which renders databases incompatible and hinders data consolidation. Even if common data elements were adopted, database administrators would be faced with high manpower costs for the time needed for manually bringing existing databases into compliance with the new standards. However, developers of future databases could adopt common standards to allow wide distribution of available data among agencies and individuals, increasing the applicability of the data.

DATABASE COORDINATION

Questions of data compatibility among Federal agencies have been raised for many years. For data to be compatible, those who collect and compile data must use consistent terminology and definitions for each data element. Such standards, spelled out in a "data dictionary," allow data to be interpreted and used by persons other than those who collected the data or created the database.

Making databases compatible among and within agencies would increase the potential for sharing information, thereby increasing the utility of all data generated. If agencies could pool their data resources, comprehensive regional and national information might be available on biological diversity in the United States. At the least, it would be possible to determine where gaps occur in the information that is available currently, and priorities could be established for future data collection.

Steps have been taken within the past decade or so to formulate standards for biological data. The motivation to establish compatible databases came partly in response to congressional mandates for national inventories and assessments (e.g., the Forest and Rangeland Renewable Resources Planning Act, Federal Land Policy and Management Act, Soil and Water Resources Conservation Act, and Forest and Range Research Act). Budgetary and manpower shortages for biological inventories provided additional motivation for sharing data. Coordination among institutions increases their abilities to share knowledge of biological resources.

Existing Institutional Coordination

A number of formal interagency cooperative agreements were signed in response to congressional directives and State of the Environment Addresses by President Jimmy Carter in the late 1970s. Among these, the Interagency Assessment and Appraisal Liaison Committee (IAALC) and the Interagency Agreement Relating to Classification and Inventory of Natural Resources (5 WAY) have taken action directly related to the collection and maintenance of biological data.

The IAALC was formed to coordinate resource assessment activities between the SCS and the FS under the authority of the Soil and Water Resources Conservation Act (RCA) and the Forest and Rangeland Renewable Resources Planning Act (RPA) assessments. Because the RCA assessment requires inventories mostly on non-Federal lands, and the RPA assessment requires inventories mostly on Federal lands, coordination between the two assessments could establish comprehensive data on most of the contiguous United States. One of the achievements of the IAALC was standardization of permanent plots in areas where the assessments are overlapping or adjacent. By using the same permanent plots for data collection, the two agencies could work cooperatively to collect data at those sites, reducing the duplication of agency effort.

Members of the IAALC also are working on standardizing terminologies for land cover to use in the assessments so that data can be interchanged between the RCA and RPA assessments. An effort to develop standard classifications for rangeland vegetation types is in the planning stages. The committee members plan to produce a joint RCA-RPA assessment report on wildlife habitats in conjunction with the 1989 assessments (5). This coordination of major national biological inventories could provide important insight into the status of wildlife and their habitats—one aspect of biological diversity in the United States.

The other major cooperative effort between Federal agencies, the 5 WAY, was formed to develop standards for land and water classifications and terminology in natural resource inventories, including biological inventories (4). The cooperative agreement was signed by five agencies (BLM, FWS, U.S. Geological Survey, FS, and SCS), which gives the agreement its nickname. Working groups were established to address specific areas of interest, such as land-cover terminology, vertebrate-species nomenclature, and land or water classification. Standards adopted by the 5 WAY were sent to the signatory agencies with recommendations that the standards be adopted into official agency policy.

The 5 WAY adopted a common nomenclature for vertebrate species in the United States and a common terminology for types of land use and land cover (e.g., definition of a forest land). However, neither of these standards for inventories has been incorporated into agency policy by all of the agencies represented by the 5 WAY. Other efforts towards standardizing inventories include an analysis of a common classification system for land use and land cover (3) and an evaluation of the FWS wetland classification system (2). The vegetation-classification system is under informal review or "field truthing" to determine whether the system is applicable to any given field location (8). A wetland plant species list and classification of hydric soils will be formulated to complement the wetland classification system.

Except for the vegetation classification group, all of the working groups under the 5 WAY were disbanded in 1985 (7). However, the policy groups will continue to meet and exchange information on activities that may be of interest to other agencies and to provide opportunities to coordinate their limited manpower and financial resources.

The success of the IAALC and the 5 WAY coordination efforts depends on whether the agencies officially endorse the committee recommendations and integrate them into existing programs. Adoption of these standards could increase the utility of future databases by allowing agencies to interchange data. Standards that improve the potential for data consolidation also promote efforts to develop national coverage of data on biological diversity.

Another cooperative effort is occurring in the Multi-State Fish and Wildlife Information System project, in which several Federal agencies have provided financial and technical assistance to coordinate statewide databases of fish and wildlife species. These databases are designed to have compatible formats and data sets as the core portion of the State databases, so that the same kinds of information will be available from each of the databases. Beyond adopting this core of data standards, States add into the system the data they feel will be useful to their needs. Federal agencies cooperating with the project hope to establish a comprehensive clearinghouse of information about fish and wildlife within each State. The clearinghouse would provide reliable baseline data for formulating projects' impact statements. Statewide information systems are currently operating or are under consideration in more than 12 States. If the systems in different States are compatible, regional or even national information on fish and wildlife diversity could be compiled.

Efforts at sharing information also occur between government agencies and private organizations. TNC provides information on biological diversity to Federal agency personnel. TNC and State Heritage Programs provide Federal agencies with inventory data and expertise in devising plans or developing management strategies that can help to maintain biological diversity.

Each of these information-sharing efforts can increase the ability of Federal agencies to maintain biological diversity. The efforts also help increase the utility of data being collected on biological resources. However, the lack of a nationwide database on U.S. biota may continue to hinder a comprehensive evaluation of biological diversity.

Suggestions for a National Biological Database

Federal and State agencies, private organizations, professional biologists, and legislators are joining in the discussion on the need for a national effort to coordinate biological data. The suggestions for what a national biological database should be, how it could be organized, and how it could be funded, are as varied as the people discussing the effort (1).

A national database for biota could be a catalog or list of organisms that reside permanently or temporarily in the United States. The database could incorporate existing taxonomic information from field and lab identifications of each species. A national database also could include existing ecological information on each species (e.g., food and reproductive requirements, habitat affinities, and interspecific interactions). In addition, it could include information on species interactions by identifying and cataloging ecosystems throughout the country.

Each of these approaches to a national database would incorporate different kinds of data and would serve different purposes. No agreement has been reached yet on what purpose a national database should serve. A species listing could be used to help determine the biological diversity within the United States as well as to help identify taxonomic categories where little is known about the diversity of species. A taxonomic database could be a centralized source of data for field manuals and synthesized reports to assist biologists in identifying species on-site. The inclusion of ecological data could help people making decisions about on-site planning and management activities to maintain biological diversity.

Most observers agree that a national biological database should incorporate existing databases and institutions. Questions remain unresolved as to how they should be incorporated and what institutional arrangements would be needed. No division of institutional responsibilities has been proposed.

One approach would be to establish a central clearinghouse or distribution point for information on existing biological databases. The clearinghouse could provide basic information on the availability of biological data and the compatibilities with other databases having similar kinds of data. The clearinghouse could use a bibliographic database to store and manage descriptions of the multitude of biological databases that currently exist. With a bibliographic information system, existing sources of information and any new sources could be accessed in an easily searchable format.

Another approach would be to create a network of satellite databases around the United States to provide actual data on biological resources. The network could serve a centralized computer facility for accessing data, without the need for a large mainframe computer or series of mainframe computers to handle all available biological data. Data managers from regional locations could feed data into the system and retrieve data out of the system, provided some standards were established for entering data into the network. Either approach would allow managers and decisionmakers access to information that could be used to effectively maintain biological diversity.

Establishment of a clearinghouse or database network would require designation of a central coordinating institution—either a new institution or an existing institution. To assign coordination responsibilities to a new institution would require an act of Congress. The new institution would need authority to work with existing Federal agencies to obtain information about their databases or to obtain data from the databases. Delegating authority to an existing institution to coordinate data activities might also require an act of Congress. In the absence of legislative action, several institutional mechanisms for interagency cooperation exist, including formal interagency agreements and memoranda of understanding. If existing institutional mechanisms were used, the interagency efforts would need enough authority to affect agency programs and policies. Although previous interagency cooperative efforts to coordinate data and data collection, including the 5 WAY, made strides in the direction of cooperation and standardization, the agencies did not follow through on recommendations from these efforts. Legislation may be necessary to ensure that such cooperative efforts affect agency activities.

Lack of funding would constrain the development of a national database that identified what information was available on biological diversity and provided access for effectively using that information. Federal agencies might be reluctant to finance a database coordination effort unless the products of the database were directly applicable to the agencies' missions. A survey funded and supported exclusively by private efforts might preclude access to some government agency data. The use of Federal funding, however, would require that trade-offs be made with existing programs in order to finance a new one.

Another negative aspect of a centralized approach to data access might be the need to develop lines of communication with data collectors and administrators. Information on any databases that were developed would have to be provided to an agency's central office for that office to be effective. This would increase the paperwork associated with database development. In addition, establishing a centralized office to transfer data would require trade-offs with existing programs within the agency. However, the dollar savings from increased compatibility of data and better access to data appear to outweigh the costs of developing these functions within and among agencies.

Prior to the development of a national database on sources of biological information or biological data, a national assessment of existing biological data is necessary. To date, no comprehensive national assessment of biological data or of existing Federal databases has been undertaken. Based on the results of a national assessment of biological data, decisions could be made on the best way to manage existing information. A national assessment also would delineate gaps in geographic or taxonomic knowledge of U.S. biological diversity that could be used to set priorities for future data collection.

Although there are technological barriers to creating a national database, they are not insurmountable. Many technological problems may be overcome if the users of the database are willing to compromise as to the objectives and methodologies chosen to link existing databases or to develop a new database. In any event, technological innovations already are facilitating the collection and use of biological data for the maintenance of biological diversity. Chapter 4 discusses those technological innovations relevant to biological data.

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Chapter 4

Technical Aspects of Biological Data

Chapter 4

Technical Aspects of Biological Data

HIGHLIGHTS

- **Automation and computerization have provided and should continue to provide many tools to increase the quality and quantity of biological data, to store and manipulate data, and to increase access to data.**
- **These tools also can perpetuate data incompatibility and inaccessibility.**

DATA COLLECTION

Data-Entry Technologies

Developments in automated data-entry systems for use in the field can improve data collection by reducing data-entry errors. These portable systems remove unnecessary intermediate steps. Traditionally, biological data have been recorded on collection forms and carried by hand to central processing facilities to be copied onto computer coding forms. (Figure 1 shows the paths along which data are transferred by conventional methods and by automated data-entry systems.) Developments in the technology of electronic hardware have resulted in small solid-state memory units with increased storage capacity and longer lasting batteries. These advances have permitted the recent development of dependable, portable devices for entering and storing data in the field. When such devices are used, data are immediately recorded in a computer-compatible form, and intermediate steps of transcribing data are eliminated (11). However, eliminating intermediate steps may mean that not all parts of the field data are entered into the computer, therefore some valuable information (e.g., animal behavior) may be lost. Moreover, these portable computers may not be rugged enough for some kinds of field work where dust and moisture are a problem.

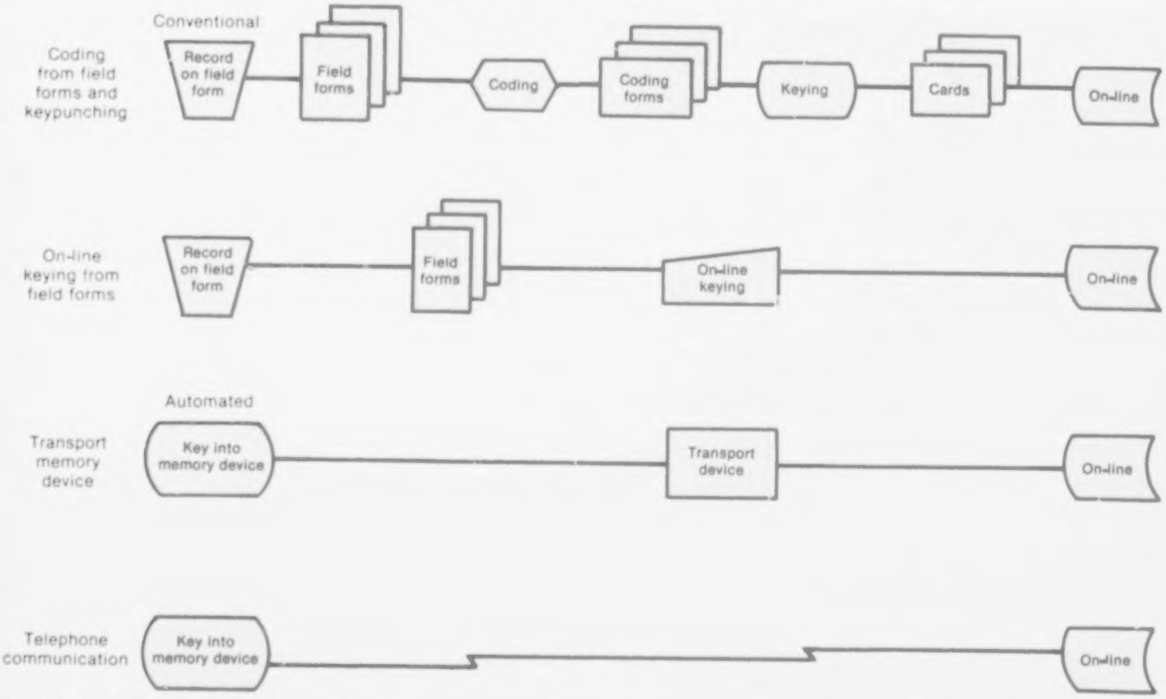
The data-entry process has also been simplified by developments in optical-character-recognition technology, which makes it possible to scan and convert printed materials into digital form. Companies are beginning to market technologies that can scan and digitize almost anything that is printed on a piece of paper. Once digitized, the image is stored on a microcomputer diskette from which it can be accessed and manipulated. Errors occur in copies or field forms but the problems are in the process of being solved. Although this technology provides opportunities for capturing graphic material, the large amount of memory required for storing the images makes the technology relatively expensive (7).

Remote Sensing Devices

Other significant technological advances in data collection have occurred, improving the quality of data and broadening the scope of the data collected. One such technology is remote sensing, which has developed rapidly during the past 25 years as one benefit of space research.

Remote sensing means gaining information without direct contact (6). Remote sensing technology includes aerial photography, radar, infrared imagery, and other devices. With regard to on-site maintenance of biological diversity, remotely sensed information is most commonly used when preparing inventories to establish baseline data and to allow monitoring of changes that occur over time. For instance, remote-sensing imagery can detect large animals, such as seals, caribou, and pelicans, thus providing a means to census animal popula-

Figure 1.—Paths of Data Transfer for Conventional and Automated Data Entry


Conventional
Coding from field forms and keypunching
Record on field form
Field forms
Coding
Coding forms
Keying
Cards
On-line
On-line keying from field forms
Record on field form
Field forms
On-line keying
On-line
Automated
Transport memory device
Key into memory device
Transport device
On-line
Telephone communication
Key into memory device
On-line

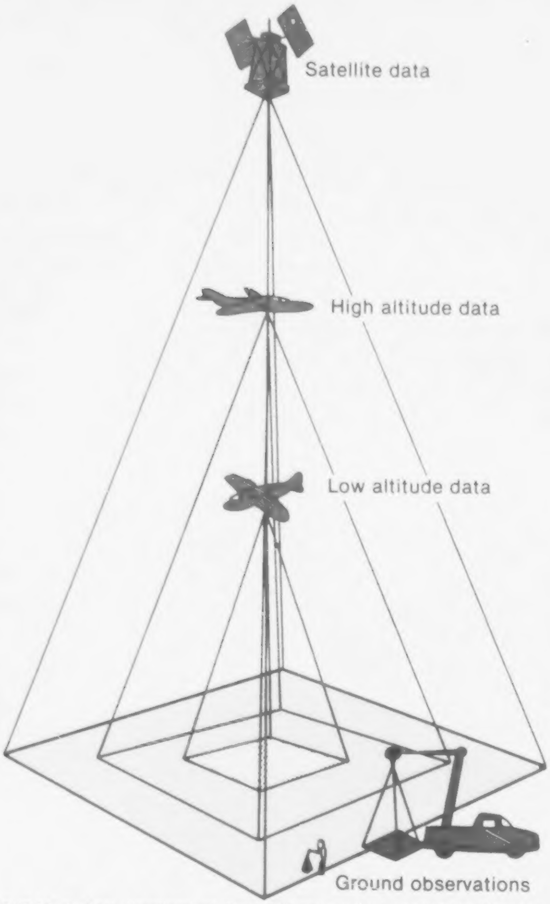
SOURCE: J. A. Newcomer and J. Szajgin, "Evaluation of an Automated Field Data Entry System," *In-Place Resource Inventories: Principles and Practices—Proceedings of National Workshop* (Orono, ME: University of Maine, 1981).

tions. However, the utility of this type of data is significantly reduced by several factors, including interactions between the color of the animal and the color of the background, and the obscuring effects of vegetative cover (10). The use of thermal-infrared scanning, which senses temperature differences between animals and their backgrounds, apparently has met with limited success (3).

Remote sensing has been used more as a tool for studying vegetation than for studying animals. Aerial photography is used when detailed habitat data (e.g., information about vegetation cover) are required for relatively small sites. Landsat is used for general reconnaissance surveys of large areas, because it provides multiple views at low cost. Landsat imagery is used to delineate crop production regions or specific forest types. Its repetitive coverage makes the Landsat system useful for temporal monitoring of habitat changes. Low-level aerial photos, especially color infrared, are much better than satellite imagery for showing the dominant genera and species of vegetation. Even so, this type of information is more reliable if supported by field verification (see figure 2) (2).

Although remote sensing has been used routinely by government agencies and other organizations to collect biological data, its costs are often high, especially where time-effective imagery is necessary, making it unaffordable for the average user. Other problems, such as unfavorable weather conditions, frequently prevent aerial photos or satellite images from being available for the season that would provide the best biological information. Special skills are required to interpret and use the information derived with some of the technology. And

Figure 2.—Remote Sensing Devices Increase the Coverage of Area From Which Data Is Collected



SOURCE: R. Best, *Handbook on Remote Sensing in Fish and Wildlife Management* (Brookings, SD: Remote Sensing Institute, South Dakota State University, 1983).

in some cases (e.g., monitoring changes in species composition within a small area), the level of resolution may not provide as much detail as field verification does for the kinds of data that are most useful.

The use of remote-sensing devices in coastal areas also presents a variety of problems. The vastness of coastal zones necessitates coverage of extensive areas. Urban areas and near-shore waters are heterogeneous, however, which means that high resolution of the land coverage is needed to identify habitat patches. Information must be provided about the sea's surface as well as its subsurface down through the water column to identify ocean biota. To further complicate the matter, cloud cover in coastal zones requires either more frequent scanning or cloud-penetration capability, raising the cost of the technology (15).

DATA STORAGE

Developments in storage technology over the past 20 years have increased the options for storing data. Information-storage technology probably is the topic of greatest interest to those responsible for managing biological data.

Software

Biological data may be stored in unstructured flat files—two-dimensional files in which data are entered in the order received. But a structured database management system (DBMS) greatly increases the efficiency of data storage and use. The added efficiency results from the fact that most biological databases are dynamic and open-ended: that is, new parameters are added, old ones are dropped, and new ways of examining data are to be expected (4).

A DBMS is a software system that provides access to the database and accommodates a variety of applications using the same data. Most of the generalized DBMSs in use today were developed in business environments and were influenced by the problems with hardware, software, and other factors encountered there. Most of the systems are oriented toward modifying and retrieving formatted data, such as inventories and accounts. Many business-oriented DBMSs are successfully applied to scientific data, particularly for low-level tasks such as keeping structured records and generating reports (14).

Systems designed specifically for managing scientific data began appearing in the early-1970s (9). Most of these systems either lack full sets of data management operations or are specialized. Management of scientific data is most advanced in well-funded areas, such as defense, medicine, and industry-related research, and least advanced in the biological sciences (9).

Some difficulties in designing databases reflect the extreme complexity of the natural environment. A database is an abstraction of the natural system, which cannot be described in all its original detail. Problems with definition of abstract entities occur in such tasks as delimiting entities (from the continuous whole); distinguishing like-entities (e.g., assigning unique identifiers to each pine tree); and identifying changes in the essential natures of entities (1). Some problems with modeling a natural system result from insufficient knowledge of the system itself. Deciding what biological attributes to include for each entity can be a major problem in designing a database, because the types of questions to be analyzed are not yet fully known.

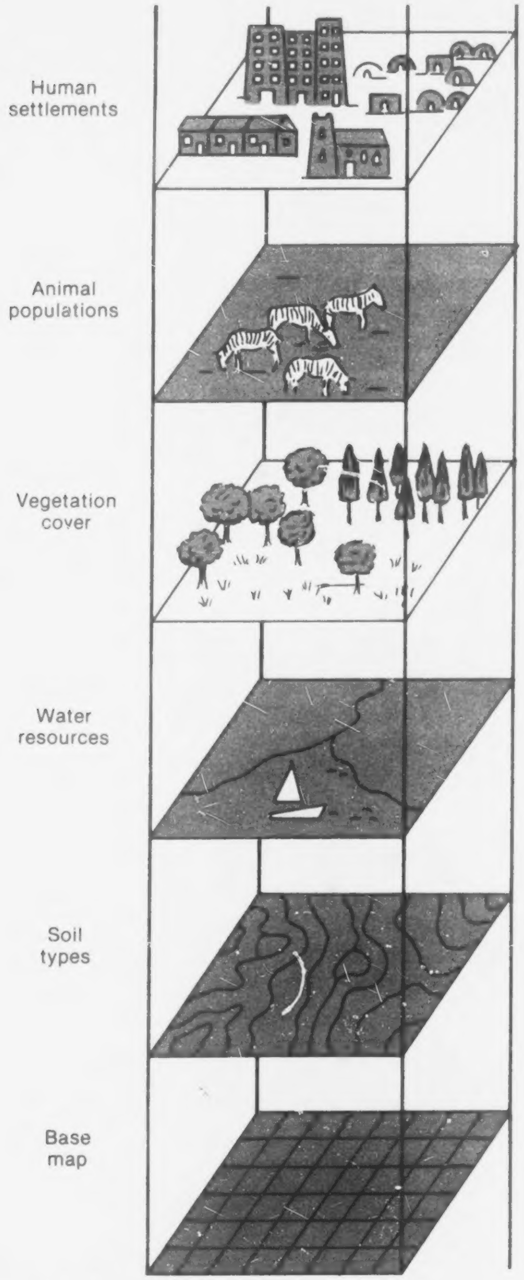
The majority of biological databases available today do not contain the data necessary for spatial analysis (e.g., geographic distribution of a species) and plotting of the spatial data. A special type of data management system, known as *geographic information system* (GIS), has been developed to handle explicit spatial data, make necessary calculations, and plot that data as required. A GIS is particularly useful to biological diversity maintenance because it provides the means to present an integrated view of a geographic area by, for example, overlaying several kinds of data. Overlay mapping allows a view of the distribution of plant and animal species over a large area and reveals the factors (e.g., roads, streams, different habitat types) that might have influenced such a distribution. (Figure 3 illustrates the kinds of information that can be overlaid.) (See the American Farmland Trust 1985 survey of GIS softwares for more information.)

GISs can display any information capable of being mapped on graphics terminals. Most of the several types of GISs can generate overlays and display maps and can change scales readily. The more sophisticated ones can compute areas, distances, peripheries, and intersections; and use shading to enhance understanding. Recent advances allow color coding and color display and printing. Major Federal land managing agencies (e.g., the Bureau of Land Management, the National Park Service, the Fish and Wildlife Service, and the Forest Service) have been using, or are beginning to use, GISs to map natural resources and to conduct project impact assessments.

The large volume of spatial data required to run a GIS restricts its application to small areas. As the level of resolution increases, the volume of spatial data increases, which means that the storage capability must also increase. Unpublished estimates by the Defense Mapping Agency indicate that a world database at the 10-meter level would require a storage capability on an order of magnitude larger than any database known at this time (10). Consequently, many GIS applications in the United States cover only project-specific areas. The largest civil GIS operational today, the Canada Geographic Information System, which is operated by Environment Canada, covers the developed portion of Canada and is still acquiring data nearly two decades after establishment (10).

A major problem in spatial databases today arises from the desire to represent different levels of spatial generalization within the same database or to change the level of generaliza-

Figure 3.—Representation of a Main Geographic Information System Function of Overlaying Several Types of Environmental Data



SOURCE: United Nations Environment Programme/Global Environment Monitoring Systems, *Global Resource Information Databases (Nairobi: GEMS Publication, 1985).*

tion once the database has been created. Where multiple levels of spatial generalization are required, the current solution is to create multiple copies of the database, one for each different scale. Other limitations of GISs include their high maintenance costs, the labor intensiveness of digitizing data, and the need for technical expertise to operate the system. A Forest Service brief estimates the initial installation cost of a GIS to be $50,000 to $100,000.[1] Finally, different systems cannot easily share data when the data are stored and handled in different and incompatible ways.

Hardware

Significant hardware developments include 30-fold gains in processing speed, major increases in reliability and storage capacity, dramatic reductions in the sizes and prices of equipment, and improvements in display resolution and graphics capabilities. Data management and analysis have relied primarily on mainframe computers, which are fast, have large memories, and are very expensive. Minicomputers offer many of the characteristics of mainframes at substantially lower prices. Because of storage and processing limitations, however, a minicomputer cannot serve as many users as a mainframe can serve (12).

Microcomputers have revolutionized the computer industry. They are fast enough for most single-user applications and perform best on tasks requiring quick responses. Recently, however, a new class of computers based on the latest 16- and 32-bit[2] microprocessors has been developed. These supermicrocomputers bridge the gap between the micros and the minis, offering minicomputer capabilities while serving several users at one time. The supermicros now cost between $10,000 and $50,000, but they should become less expensive within the next few years (12).

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[1] This figure is intended only to give a general idea of the magnitude of cost.

[2] Generally, the larger the bit size, the greater the amount of memory a computer can manipulate at any given time, and the faster the manipulation. Therefore, 16- or 32-bit microcomputers are faster and can handle more data simultaneously than the 8-bit micros developed 5 to 10 years ago.

Major developments are also taking place in magnetic storage, optical disks, and a combination of magnetic and optical storage (7). Magnetically stored data is recorded by repeatedly polarizing tiny areas along the surface of the magnetic medium. The size of the polarized areas and how closely together these areas can be packed determine storage capacity. Technological advances continue, allowing more and more bits of data to be packed into given areas.

An optical disk typically stores data as a series of spots on a light- or temperature-sensitive medium. The technology seems ideal for preparing multiple copies of archival data as information is digitized onto a master disk and then replicated for distribution. The lifespan of the optically recorded information is projected at more than 40 years (7). The major disadvantage of optical storage when compared to magnetic storage is that the data cannot be erased.

Efforts to develop erasable optical-storage media currently combine magnetic and optical technologies. Heat from a focused laser beam is used to impose a magnetic orientation. This information then can be read using polarized laser light. As the method of storage is magnetic, information stored in this fashion can be erased to free disk space for the storage of new data.

DATA RETRIEVAL

Until recently stored data had to be retrieved by searching card catalogs and agency file cabinets or by making telephone or mail inquiries —very time-consuming tasks. Today, technological developments have facilitated the ease with which data can be retrieved. Improvements in telecommunications, in particular, have increased the number of options.

Data transmission via telephone is one of the fastest growing fields in the information industry. This growth has been spurred by such developments as fiber-optics technology, which promises improved efficiency and lowered costs. Using laser light and a bundle of glass strands, it is possible to transmit more than 240,000 telephone conversations simultaneously. The major problems with telecommunications for data transmission at present are the comparatively high costs, relatively slow speeds, and fairly high error rates. Satellite technology has great potential to reduce the cost of long-distance transmissions. Because telecommunications depend on the quality of the phone connections, their reliability varies with location and time (8).

The same telecommunication technology that provides access to a large centralized database also facilitates access to smaller databases distributed in different localities. Advances in telecommunication technology make it increasingly practical to build small, local databases that can be remotely accessed and maintained. With the aid of special software to facilitate access, the user can easily access data residing on different computers. Data at available varied locations can be searched, modified, or moved from one computer to another (transferred from a mainframe to a microcomputer, for example) for future use (7).

Telecommunication developments also have facilitated the use of data in printed form. Microcomputers coupled with optical scanning devices can now be used to store printed images, which can be transmitted to remote locations.

OPPORTUNITIES AND CONSTRAINTS

Automation and computerization have provided many tools to increase the quality and quantity of biological data collected, to store and manipulate data in a variety of forms, and to allow more users to have access to data. Computer software and hardware are changing rapidly, are becoming easier to handle, and are less costly to acquire and maintain. The range of new technologies, however, can present some difficulties that require careful planning to overcome.

Many software packages exist, and more are being developed. Software for many operating systems is available in the public domain, but documentation of public domain software tends to be poor, and problems using the programs are common (13). Commercial software packages often are better documented than custom software or software developed in-house. Moreover, the costs of the latter may be higher than those of commercial software when the hidden costs, such as salaries, are included. In addition, the utility of custom or in-house software may decline when the original developers or users leave, taking away their intimate knowledge of the system (5).

The variety of technological options brings problems as well as opportunities. At present, biological databases are fragmented, and each is designed for its own purpose. (See ch. 3.) This situation creates incompatibilities that may hinder the process of linking databases together or of simply exchanging data between agencies. The diversity of technologies can exacerbate this problem. Caught up in computer enthusiasm, individual database managers may use different software programs or create their own programs, making it difficult to access data on another agency's computer. For example, delineating the goals of data collection before acquiring the software and hardware could minimize the use of several types of software (that may be incompatible) within a particular project or program. Therefore the technical aspects of database development could benefit from careful planning and coordination. To ensure such coordination in planning, designing, implementing, and maintaining databases would require high levels of institutional support.

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Chapter 5
Summary Findings

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This background paper describes the extensive activity undertaken by the Federal Government, mostly as a result of legislative mandates to collect biological data. The paper points out that very little of the Federal data can be easily applied to the maintenance of biological diversity, because the data are scattered throughout many agencies, maintained in various forms, and stored in different, and frequently incompatible, systems. These factors make it very difficult, if not impossible, to retrieve, compare, and consolidate the data for use in designing strategies for on-site maintenance of biological diversity in the United States. Many of the problems, however, could be easily solved or avoided in the future with strong institutional commitments to coordination and cooperation in collecting and applying biological data.

The following is a brief discussion of this paper's three major findings concerning biological data.

FINDING 1:
Few of the numerous mandates for Federal agencies to collect biological data or to maintain biological databases are directly applicable to the maintenance of biological diversity in the United States.

A body of Federal legislation authorizes various Federal agencies to collect and compile selected information on plant and animal life in the United States. (See ch. 2.) As a result, numerous Federal agencies conduct biological inventories, creating enormous quantities of biological data that address various aspects of biological diversity. Because few of these laws explicitly cite the maintenance of biological diversity as an objective, biological diversity is not considered in a comprehensive or coherent manner. The legislation usually directs or authorizes an agency to conduct inventories, but the mandates can be interpreted differently by different individuals within and among agencies. Due in part to the differences in agency objectives and in the interpretations of agency objectives and directives, the information collected on individual organisms and on taxa varies considerably. Data gaps exist geographically and taxonomically. Some taxonomic groups generally are ignored in field inventories. Others, particularly plants and animals with economic or recreational value, are inventoried extensively by more than one Federal agency. As a result of all these factors, existing biological data cannot be easily applied to decisions regarding the maintenance of biological diversity.

One solution to this problem would be an explicit mandate to the appropriate Federal agencies to compile existing data on the status of biological diversity in the United States and to conduct periodic reviews of this diversity. The result could be agency cooperation similar to that undertaken by the U.S. Forest Service and the Soil Conservation Service in their joint assessment of wildlife and its habitat under the Soil and Water Resources Conservation Act (RCA) and the Rangeland Renewable Resources Planning Act (RPA) (see ch. 3), although appraising biological diversity would involve more than two Federal agencies. In addition, Federal agencies could be required to consult with appropriate State agencies (e.g., Natural History Surveys) or private organizations (e.g., The Nature Conservancy) to locate sources of biological data that are not available within the Federal system. The compilation of existing biological data for the maintenance of biological diversity could take a number of forms. (See ch. 3.)

The process of identifying and compiling existing biological data relevant to the maintenance of biological diversity would help to pinpoint areas where data overlap or are lacking. At the least, such a process would initiate activities to coordinate the collection and entry of data and, thus, would facilitate the retrieval of data. As with the RCA-RPA process, one benefit of coordination might be the establishment of standards for data collection and data entry.

In addition, existing Federal laws authorizing biological inventories would need to be reviewed to eliminate potential conflicts or inconsistencies with a new mandate for coordinating biological data. Under such a mandate, the responsibilities of Federal agencies would need to be clearly defined. Otherwise, the mandate could increase the quantity of biological information and perpetuate the inconsistencies and incompatibilities of the data maintained by different agencies. The extent of consistency that is necessary would determine how much funding would be needed.

FINDING 2:

Rapid technological advances, especially in the computer field, could have both positive and negative effects on the collection, storage, and retrieval of biological data.

Recent advances in technologies have increased, and should continue to increase, the quality and quantity of biological data collected, and the accessibility and usability of such data. Technological advances are likely to decrease the cost of data collection, maintenance, and retrieval. (See ch. 4.) These advances include microcomputers for field data collection, new and more flexible database-management packages, and sophisticated telecommunication technologies to increase data access and retrieval.

Although new technologies provide greater opportunities for data managers and data users, the variety of computer hardware and software could exacerbate the current problems of incompatibility and inaccessibility. Technologies appear to be selected on an ad hoc basis, frequently reflecting the preference, knowledge, or expertise of individual data collectors and administrators.

Various Federal agencies have begun to coordinate database-management activities, especially in the case of geographic information systems. However, coordination among agencies in the purchase and development of information technology is extremely difficult, because different agencies have different missions, needs, and uses. Obviously, no one database-management system could meet all the needs of one agency, let alone the needs of all agencies.

A solution to these technology-based problems may be to establish an external review process that would assist agencies in setting up data networks and provide consultation on hardware and software systems. The review process could be coordinated through an agency like the National Academy of Sciences or the congressional General Accounting Office. Professional societies of both resource professionals and computer specialists could play a role in designing office systems that would meet the needs of most users and would allow compatibility in hardware and software among users within an agency. Formal consultation with computer specialists could provide independent review of the utility of existing computer systems and could help agencies set priorities for purchasing additional hardware and software to meet agency needs. Because outside consultants would need to work closely with automated-data-processing personnel and database administrators within each agency, a mechanism to establish dialog between agencies would have to be developed. Once such a mechanism were established, standardized data mechanisms for data exchange could be developed.

The cost of establishing database hardware and software compatibility among and within agencies would depend on the extent of communication desired. An overall system plan that linked all potential users of the data, providing links between offices and between geographical regions, would be costly in the short term because it could require the purchase of new data systems or the reprogramming of existing systems to fit a standard framework. Careful planning and institutional coordination would substantially reduce the need to make hardware or software changes. In some cases, however, building communication between database-management systems might be as simple as purchasing telephone modems or exchanging diskettes containing data through the mail.

FINDING 3:

Lack of overall institutional coordination of databases reduces the value of existing biological data, especially those housed in Federal agencies.

Although a large amount of biological information is being collected, the data tend to be site-specific, project-related, and generally inaccessible to most potential users. Individual Federal agencies frequently do not know what biological data they themselves have collected, much less what other agencies have collected. Consequently, many efforts are duplicated, and the coordination of data is limited both among and within agencies.

Inventories of Federal biological databases, such as the inventories conducted by the Fish and Wildlife Service and the Environmental Protection Agency (see app. A), help secondary users identify existing data files that might be of use. Such activities should be encouraged. Even with these inventories, however, the efforts of data collectors and database administrators need to be coordinated in order to avoid duplication within and among agencies, and to provide broad use of the data collected.

The establishment of certain standards, such as common data dictionaries, would be an important first step to data-sharing between agencies, thereby reducing the need for different agencies to collect similar data. It would, in addition, greatly aid efforts to address the technological difficulties discussed earlier. Establishing data standards, however, is a formidable task. The difficulty is exemplified by the inability of agencies to agree on even a common definition of wildlife.

Existing cooperative efforts, such as the Interagency Assessment and Appraisal Liaison Committee (IAALC) and the Interagency Agreement Relating to Classification and Inventory of Natural Resources (5 WAY), have been working to standardize the data collection processes and classification systems of different agencies.[1] (See ch. 3.) These interagency committees also exchange information about data collection and consolidation activities within the member agencies. For example, a working group under the 5 WAY recently completed an inventory of natural resource databases available within the member agencies.

Coordination could be formalized within the Federal agencies through the establishment of a national biological database, or each agency could ensure that one centralized office would remain aware of database activities within that agency. (For discussion of a national database see ch. 3.) In a few cases, individual Federal agencies have designated offices or personnel to serve such a function, but most agencies have no agencywide coordination of biological data. Centralized offices could serve as clearinghouses of data, improving the access managers and researchers within the agency have to data, as well as providing a source of public information for State and private institutions. Personnel within the centralized offices could assist the agencies in reviewing data compatibility (of technology and of the kind of data collected and maintained), which could reduce the agencies' costs for maintaining data. Although centralized offices for data coordination would not eliminate the need for interagency cooperation under agreements like the 5 WAY and the IAALC, centralized offices should greatly facilitate interagency cooperation.

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[1] Although these interagency groups have led to agreements on data nomenclature standards and land-cover terminology standards, these agreements are not incorporated into the policy and practices of each agency represented in the interagcy cooperative effort. If agency policies do not reflect the interagency agreement, these committees do little to standardize activities beyond merely providing a forum for communication.

Appendixes

Appendix A

Examples of Federal Agency Databases Containing Biological Information

Methodology

Many Federal agencies maintain databases containing biological data. A survey was conducted between June and December 1985 to determine the approximate number, scope, and coverage of these databases. The survey began with an examination of information from existing database inventories (20,38,61,62,64,71), followed by telephone calls to determine the status of previously published surveys. These calls led to identification of other contacts and databases. This approach had a built-in bias toward databases known to a wide audience. Therefore, more databases of national or regional coverage were identified than were databases of local, sub-State, or State coverage. No attempt was made to develop a comprehensive listing of Federal databases. The following list provides examples of the kind of biological data collected on-site by the major Federal agencies responsible for biological resources. The list probably represents less than 20 percent of the databases containing biological information currently maintained by Federal agencies.

The geographic coverage of each database is described. National databases include data consolidated from sources throughout the United States. Regional databases include data consolidated from sources within a region, such as the Pacific Northwest States. State and sub-State databases contain data from one statewide area, such as Tennessee, or from a location within the State, such as one national park. Databases are geographically categorized on the basis of where the data are located. For example, if the data are available at a specific sub-State location where the data were collected (e.g., a BLM Resource Area), the database is considered a sub-State database, regardless of whether the data are available from a number of unique locations across a broader geographic area.

The taxonomic coverage of each database also is described. The categories used for taxa are the class level for animals and the kingdom level for plants. The inclusion of data on trees within a database is noted.

Users of each database are identified in broad categories. The primary Federal agency using the data is listed first. Use by other Federal agencies or States is also noted. The "others" category includes private users, such as universities, individual researchers or interested persons, conservation or other organizations, and county officials or agencies.

If a primary contact person or office has been identified for the database, it is included.

References mentioned with the databases can be found in a list at the end of this appendix.

A summary table of this appendix can be found in chapter 3, pages 21 through 23.

Federal agencies that collect biological data but are not described in this appendix[1] include:

- U.S. Department of Agriculture, Agriculture Research Service;
- U.S. Department of the Interior, Bureau of Indian Affairs;
- U.S. Department of the Interior, Bureau of Reclamation;
- U.S. Department of Energy—Ecological Experimental Area Program;
- Environmental Protection Agency;
- National Science Foundation—Long Term Ecological Research Program; and
- Smithsonian Institution.

Existing Biological Databases

Summary of the U.S. Department of the Interior

The U.S. Department of the Interior has no central source for biological databases. The agencies considered here include: the National Park Service, Bureau of Land Management, Fish and Wildlife Service, and U.S. Geological Survey. The National Park Service recently compiled a list of microcomputer applications in agency programs (61); the list provided a starting point for this survey. In addition, a recent issue of *Park Science* discussed microcomputer applications in the natural resources division. Examples from each of these sources are included. The Fish and Wildlife Service's Office of Information Transfer is completing an inventory of FWS databases (35). Currently, no such inventory or clearinghouse of databases exists within the agency. Bureau of Land Management and U.S. Geological Survey databases were identified, in part, in the review of a recent inventory of databases prepared by a working group of the Interagency Agreement Relating to Classifications and Inventories of Natural Resources (20).

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[1] Time constraints preclude the survey of many databases maintained by agencies such as these.

National Park Service (NPS)

1. **National Park Flora (NPFLORA)**
   Content: A listing of all vegetation within each of the National Parks, including species names, taxonomic characteristics, and status from State and Federal lists of sensitive, threatened, or endangered species.
   Purpose: Designed as a reference and management tool.
   Geographic coverage: National—national park lands.
   Taxonomic coverage: Vegetation within the National Park Service lands.
   Status: Ongoing data entry as information becomes available from specific park areas. Currently available on computer for all Class I Air Quality classification sites administered by the National Park Service. Class II sites are being entered.
   Users: Park managers and interpretation specialists, other Federal agencies, States, others.
   Contact: Gary Waggoner, Science Section, Denver Service Center, Denver, CO.
   References: (60,66)

2. **The Nationwide Rivers Inventory**
   Content: Approximately 61,700 river and stream miles in 1,524 segments in the coterminous United States (2 percent of total U.S. river mileage) with data on surface flow, cultural development, and cursory fish and wildlife information.
   Purpose: To determine potential candidates for the wild and scenic rivers system for river segments greater than 25 miles in length (or less than 25 river miles if outstanding values were known).
   Geographic coverage: National—3,250,000 river and stream miles in the coterminous United States.
   Taxonomic coverage: Broad categories of fish and wildlife. No species-specific studies conducted.
   Status: Report issued in January 1982. No updates planned.
   Users: NPS planners, Congress, States, other Federal agencies, others.
   Contact: Bernie Collins, Division of Rivers, Washington, DC.
   Ecological data can be found in the regional offices for the river segments of each region.
   Reference: (11).

3. **National Natural Landmarks Program Data Base**
   Content: The inventories completed under the National Landmarks Program for 33 ecological units in the United States. Data vary between studies as does the amount of field research.
   Purpose: Surveys generally provide a very coarse filter for identifying ecologically significant areas that could be future candidates for landmark designation.
   Geographic coverage: National—all physiographic provinces of the United States.
   Taxonomic coverage: Varies by inventory but generally includes all economically or ecologically important plant and animal species.
   Status: 33 surveys complete and published. Inventories in report form and titles computerized.
   Users: NPS, States, others.
   Contact: Arthur Stewart, Division of Interagency Resources, Washington, DC.
   Reference: (52).

4. **Endangered Species Data Base**
   Content: Systemwide endangered species database to collate information from all national park units on federally designated threatened and endangered species.
   Purpose: To provide nationwide data on threatened and endangered species.
   Geographic coverage: National—all NPS lands.
   Taxonomic coverage: Federally listed threatened or endangered plants and animals.
   Status: Planning and internal review stage. Currently, southeast region has species list in notebook; midwest and northwest regions have contract with FWS to identify species; and southwest region has list of species and occurrences on a word processor.
   Users: To be determined, depending on design of system.
   Contact: Nick Churin, Division of Biological Services, Washington, DC.
   Reference: (10).

5. **Coastal Barriers Inventory**
   Content: Information on the location, physical and natural characteristics, ownership and administrators, and protected status of coastal barrier islands.

Purpose: Used to determine potential additions or deletions of units from the National Coastal Barrier Resources System.
Geographic coverage: National—coastal areas.
Taxonomic coverage: Unknown.
Status: System is on a computer and is updated regularly.
Users: NPS, Fish and Wildlife Service, U.S. Geological Survey, States, others.
Contact: Audrey Dixon, Science Support Staff, Division of Natural Resources, Washington, DC.
Reference: (23).

6. **COMMON**
Content: Summary: type information on park adminstration, acreage, natural and cultural features, and planning documents.
Purpose: To provide NPS staff with easy access to park-by-park information.
Geographic coverage: National—all park system units.
Taxonomic coverage: Unknown.
Status: An initial phase of COMMON is entered in a computer.
Users: NPS staff, could be available to other agencies and private organizations or individuals.
Contact: Ann Frondorf, Natural Resources Operations Support Staff, Washington, DC.
Reference: (23).

7. **North Atlantic Region Resource Data**
Content: Data on vegetation and soils and on air and water quality for NPS lands in the region.
Purpose: Used in research projects as baseline information and also for analysis of changes in vegetation over time, either naturally or as a result of air and water quality changes. One goal of the system is to network all national park offices into regional databases.
Geographic coverage: Regional—units of National Park Service region.
Taxonomic coverage: Vegetation.
Status: Ongoing data-entry from research and management programs. At least four units are linked into the system. Data digitized for mapping.
Users: NPS staff.
Contact: Office of Scientific Studies, North Atlantic Region, Boston, MA.
Reference: (21).

8. **Wild and Scenic Rivers Program**
Content: Designated wild and scenic rivers were inventoried for cultural, ecological, geological, historical, and recreational value.
Purpose: For inclusion in the Environmental Impact Statements for each river segment designated.
Geographic coverage: Sub-State—60 percent river segments congressionally designated as wild and scenic rivers.
Taxonomic coverage: Varies according to the river segment but generally includes fisheries and vegetation.
Status: Reports are no longer being written due to manpower and funding constraints. Data no longer being collected.
Users: NPS, other Federal agencies, States, Congress, others.
Contact: John Huebert, Division of Rivers, Washington, DC.
Reference: (64).

9. **Biosphere Reserve System Data Files**
Content: Six reserves have attempted to collate all environmental information into volumes from disparate sources.
Purpose: For research and public interest use.
Geographic coverage: Sub-State—Smoky Mountains, Glacier, Organ Pipe, Isle Royale, Olympic, and Big Bend National Parks.
Taxonomic coverage: Varies depending on reserve but all reserves have basic information on flora and vertebrates.
Status: Smoky Mountains and Glacier manuals are published. Organ Pipe, Isle Royale, Olympic, and Big Bend are awaiting publication. Efforts to collate information from other reserves have not occurred.
Users: NPS, States, others.
Contact: Bill Gregg, Man and the Biosphere Program/NPS office, Washington, DC.
Reference: (27).

10. **Bear Information System**
Content: Records of all sightings, and management actions for trapped or radio-tagged bears.
Purpose: For writing reports on bear activities and developing management options.
Geographic coverage: Sub-State—Yellowstone National Park, Montana and Wyoming.
Taxonomic coverage: Black and grizzly bear.
Status: Data input ongoing on microcomputer system.
Users: NPS employees.
Contact: Elfrida Kaminski, ADP Coordinator, Yellowstone National Park, WY.
Reference: (61).

11. **Ground Cover System**
    Content: Data on vegetation plots.
    Purpose: To determine aspects such as species diversity of each plot and to print species lists from each plot.
    Geographic coverage: Sub-State—Yellowstone National Park, Montana and Wyoming.
    Taxonomic coverage: Plants.
    Status: Data-entry ongoing on microcomputer system.
    Users: NPS research scientists and naturalists.
    Contact: Elfrida Kaminski, ADP Coordinator, Yellowstone National Park, WY.
    Reference: (61).

12. **Vegetation Data Base, Great Smoky Mountains**
    Content: Information on plant species within the national park and surrounding areas. Data include name, life history, habitat, distribution, status, and air quality or other potential impact information. One unique aspect of the data is information on the ethnobiology of a plant in southern Appalachian culture.
    Purpose: To manage information on the diverse flora, allow easy update of the plant checklist, and facilitate planning efforts with accessible data on plant distribution and ecology.
    Geographic coverage: Sub-State—Great Smoky Mountain National Park, Tennessee and North Carolina.
    Taxonomic coverage: Plants.
    Status: Update and maintenance of the system is ongoing.
    Users: NPS personnel, others.
    Contact: Peter White, Uplands Field Research Laboratory, Great Smoky Mountains National Park, Gatlinburg, TN.
    Reference: (69).

13. **Channel Islands Information System**
    Content: Extensive information on approximately 2,000 species occurring in the national park. Data include species name, abundance, distribution, reproductive biology, population age and sex compositions, and growth rates.
    Purpose: To manage and analyze population dynamics data. Database also used in interpretation programs and developing reports.
    Geographic coverage: Sub-State—Channel Island National Park, California.
    Taxonomic coverage: Mammals, fish, birds, invertebrates, plants.
    Status: Ongoing data-entry and update as data are generated from research efforts.
    Users: NPS research staff and park managers.
    Contact: Gary Davis, Research Science Staff, Channel Islands National Park, CA.
    Reference: (14).

Bureau of Land Management (BLM)

1. **Range Site Inventory (RSI)**
    Content: Information on plant species composition, plant production estimates, and mapping of range communities.
    Purpose: Data are used to establish livestock stocking rates and as a baseline for range monitoring studies.
    Geographic coverage: Regional—Western States, BLM lands.
    Taxonomic coverage: Range plants.
    Status: Developing computer program to combine SVIM and RSI data, scheduled for availability in 1986. Approximately 50 percent of BLM land inventoried using SVIM or RSI. Data available from State offices.
    Users: BLM, other Federal agencies, others.
    Contact: Rangeland Resources Division personnel in State BLM offices.
    References: (20,31).

2. **Soil Vegetation Inventory Method (SVIM)**
    Content: Data on range vegetation under BLM jurisdiction, including species composition, cover, height, and measures of productivity. Data were generated by range allotment.
    Purpose: Currently none.
    Geographic coverage: Regional—BLM lands.
    Taxonomic coverage: Range vegetation, some timber.
    Status: System archived and unavailable. Some data will be entered into new range system along with RSI data.
    Users: Currently none.
    Contact: Bob Waggoner, Division of Resource Systems, Denver Service Center, Denver, CO.
    Reference: (67).

3. **Integrated Habitat Inventory Classification System (IHICS)**
    Content: Combined information from districts and resources areas on wildlife habitat sites, standard habitat features (strata), and special habitat features. Inventory data is collected on standardized forms for inclusion into IHICS. Methods documented in BLM Manual Section 6602.

Purpose: To evaluate and delineate vegetation types known to be associated with specific wildlife species, for wildlife planning and management.

Geographic coverage: Regional—IHICS coverage of districts and resource areas is varied. Coverage includes some information on most of the districts in Nevada, New Mexico, and Arizona. Some has been done in Idaho and Alaska and other Western States. The agency proposes to include all Western State districts within the system.

Taxonomic coverage: Coverage of organisms varies considerably by district. Arizona has included extensive information on "nongame" species of wildlife, including breeding birds, amphibians, and reptiles. Other districts only include information on large game mammal populations and/or upland game birds. Thus far, no effort has been made to include all wildlife populations on BLM lands within the database.

Status: Ongoing effort by district offices and Denver Service Center. No anticipated completion date.

Users: BLM, States, others.

Contact: Larry Peterson, Denver Service Center, Denver, CO.

References: (20,41).

4. **Riparian/Aquatic Information Data Summary (RAIDS)**

Content: BLM-wide summary system for all riparian and aquatic resource information (plant species composition, structure of the plant community, animal species present or associated with existing vegetation) from district offices and resource areas for storage and retrieval using a standardized system.

Purpose: BLM-wide tracking system of riparian and aquatic habitat information for land planning and management. Riparian inventories are conducted in conjunction with other resource studies.

Geographic coverage: Regional—some districts already have collected data on riparian and aquatic resources for inclusion into the RAIDS. Others would be required to inventory resource areas to collect the information for each district.

Taxonomic coverage: Both aquatic plant and fisheries and animal taxa will be represented.

Status: Implemented and included in the BLM Manual Section 6602.

Users: BLM, other Federal agencies, States, others.

Contact: Larry Peterson or Paul Cuplin, Denver Service Center, Denver, CO.

References: (20,41).

5. **Wild Horses and Burros Inventories**

Content: Wild horse and burro distribution (herd area), population sizes and population structures.

Purpose: To assist in management and administration.

Geographic coverage: Regional—eight Western States where horses and burros congregate.

Taxonomic coverage: Mammals—horses and burros.

Status: BLM in process of computerizing data in central system with information on applicants for adoption program and administrative information on the horses and burros from round-up to disposition.

Users: BLM, others (animal protection organizations).

Contact: Division of Wild Horses and Burros, Washington, DC.

References: (20,48).

6. **Extensive Forest Inventory**

Content: Aerial survey with field verification of timber sites.

Purpose: To determine timber type, whether land commercial or noncommercial timber, and to outline boundaries of timbered areas.

Geographic coverage: State—Western States, timbered areas on BLM lands.

Taxonomic coverage: Timber, vegetation.

Status: All timbered areas have been inventoried with this method. Data stored in State and district office files, some on computers, some on maps.

Users: BLM, Forest Service, States, others (private timber companies).

Contact: Forestry Division personnel, State BLM offices.

Reference: (39).

7. **Forest Operations Inventory**

Content: Inventory of the forest base identified by Extensive Forest Inventory as capable of sustaining timber production.

Purpose: Serves as basis for delineating various forest practices on a specific forest.

Geographic coverage: State—Western States, BLM forested areas.

Taxonomic coverage: Timber, vegetation.

Status: Ongoing, most sites are currently evaluated. Data stored in State and district offices, some on computers, some on maps.

Users: BLM, States, other Federal agencies, others (private timber companies).

Contact: Forestry Division personnel, State BLM offices.

References: (20,39).

8. **Timber Production Capability Classification (TPCC)**

Content: Detailed forest management information on specific sites down to 10 acres in size. Data includes production capabilities and soil and environmental conditions at the site.

Purpose: The database provides the detailed planning information needed to determine how much to cut and where.

Geographic coverage: State—Western States, most of the BLM forested areas.

Taxonomic coverage: Timber, vegetation.

Status: Ongoing effort as planning information is needed. Data stored in files in State and district offices, some computerized, some on maps.

Users: BLM planning and forestry staff, other Federal agencies, States, others (timber companies).

Contact: Forestry Division personnel, State BLM offices.

References: (20,39).

9. **Intensive Forest Survey Inventories (STORMS)**

Content: Records kept from field data cards on reforestation efforts, stocking efforts, species stocked, and history of reforestation in an area.

Purpose: To combine reforestation and operation inventory data into one computer-based system.

Geographic coverage: State—Western States, BLM forested areas.

Taxonomic coverage: Timber.

Status: Ongoing data-collection effort. Data computerized in integrated system.

Users: BLM, States, timber companies, other Federal agencies.

Contact: Forestry Division personnel, State BLM offices.

References: (20,39).

10. **Wilderness Inventory**

Content: Inventory covers units of BLM lands identified as having wilderness potential. In-depth studies are underway to determine resources, resource conflicts from uses of land, and wilderness values.

Purpose: Data used in EISs and maintained in files in resource area offices.

Geographic coverage: Sub-State—10 Western States.

Taxonomic coverage: Varies depending on area, generally vegetation, timber, and some fish and wildlife.

Status: Narratives of each unit published by each State office. Inventory efforts are ongoing as part of planning process.

Users: BLM, private organizations.

Contact: Recreation specialists in resource area offices in 10 Western States.

References: (20,70).

11. **Fire Management Data**

Content: Vegetation response and resource changes from wildfires and prescribed burning. Surveys assess postfire vegetation, soil condition, species change.

Purpose: Some studies conducted to obtain data on successional changes after controlled burn.

Geographic coverage: Sub-State—13 Western States, BLM lands.

Taxonomic coverage: Vegetation, timber.

Status: Data collection ongoing. Data in unpublished, localized files.

Users: BLM, other Federal agencies, States, others (researchers).

Contact: Fire Management Officers, BLM resource area offices.

Reference: (5).

12. **Threatened and Endangered Species Data Bases**

Content: Two separate databases maintained by field offices, one for actual observations of threatened and endangered plants and the other for actual observations of threatened and endangered animals. Because the data is very site-specific, it is generally unavailable to the public, in accordance with BLM responsibilities to protect the species.

Purpose: To provide biologists and managers with easily retrievable data on the known presence and status of threatened and endangered species.

Geographic coverage: Sub-State—data maintained at field offices.

Taxonomic coverage: Plants, animals, and fish taxa; some data files have more detail than others.

Status: Standard database and input forms developed and implemented in BLM Manual Section 6602.

Users: BLM biologists and managers, other cooperating agencies.

Contact: Wildlife biologists in individual field offices where implemented.

Reference: (40).

U.S. Fish and Wildlife Service (FWS)

1. **Winter Waterfowl Survey**

Content: Data generated from annual survey (in January) by aerial and field counts at known concentration areas. Some random survey data for black ducks.

Purpose: Results are used to monitor changes in the distribution and status of populations, particularly those with inaccessible breeding grounds.

Geographic coverage: National—all flyways, southern New England south to Florida, Gulf Coast States, California, some Midwest States.

Taxonomic coverage: Waterfowl.

Status: Data recorded and computerized at Migratory Bird Management Office.

Users: FWS, States, others (researchers, flyway councils).

Contact: Robert Blohm, Office of Migratory Bird Management, Patuxent Research Center, Laurel, MD.

Reference: (20).

2. **North American Breeding Bird Survey**

Content: Information from around 2,000 roadside counts each year throughout North America. Data covers distribution and abundance of some 500 bird species.

Purpose: To track species distribution and abundance.

Geographic coverage: National—includes transects throughout North America.

Taxonomic coverage: Birds.

Status: Maintained on computer files by Patuxent Research Center.

Users: States, other Federal agencies, others (conservation organizations, researchers).

Contact: Sam Droege, Office of Migratory Bird Management, Patuxent Research Center, Laurel, MD.

Reference: (53).

3. **Mourning Dove Call—Count Survey**

Content: Data collected from 20 stops along 900 randomly selected routes. This is a cooperative Federal and State effort.

Purpose: To develop population index for hunting season and regional trend data on mourning doves.

Geographic coverage: National.

Taxonomic coverage: Birds, one species.

Status: Annual survey in the spring, conducted since 1968, data computerized at Migratory Bird Management Office.

Users: FWS, States, researchers.

Contact: David Dolton, Office of Migratory Bird Management, Patuxent Research Center, Laurel, MD.

References: (20,53).

4. **River Reach Fisheries Data Base**

Content: Survey of 1,300 stream reaches for National Fisheries Survey, a 3-volume document published in 1984. Data include species present, legal status of the species, abundance (mostly qualititative), use of stream reach by the fishery, months of use, and factors affecting survival. This is the only national survey of fisheries completed in the lower 48 States.

Purpose: Survey provided baseline fishery information. Data support water quality policies within EPA and as reference for fisheries nationally.

Geographic coverage: National—lower 48 States (except Rhode Island which was omitted when using random numbers table).

Taxonomic coverage: Fish.

Status: Tapes of data available from EPA Monitoring and Data Support Division. Raw survey forms on file at FWS Western Energy Land Use Team Office. Data partially synthesized and published. No foreseeable plan to update data.

Users: EPA, FWS, other Federal agencies, others.

Contact: Lee Ischinger, Office of Biological Services, Wetland Ecology Group, Ft. Collins, CO.

Reference: (30).

5. **Wildlife Refuge Management Information System**

Content: Umbrella system for all refuge administrative and resource information. Resource information on forms in each of the refuges will be included in system. Resource data varies depending on the charter of the refuge.

Purpose: System will provide computer links between refuges, regional offices, and the Washington office.

Geographic coverage: National—all refuges, biological information on some.

Taxonomic coverage: Variable, but will include vegetation, birds, mammals, fish.

Status: Still in the developmental stages. System will be put up over 10-year period. Pilot project will be underway with Boston regional office and five refuges in fiscal year 1986. Final goal is network linking the 400 refuges.

Users: FWS Refuge program.

Contact: Bill Brimberg, Division of Refuge Management, Washington, DC.

Reference: (7).

6. **National Wetlands Inventory**

Content: Data on wetland distribution in the United States with aerial and ground surveys. Products include detailed mapping of wetland areas of special concern and statistical study of aerial photos.

Purpose: To determine wetland acreage and wetland trends by type of wetland.

Geographic coverage: National—includes Alaska and Hawaii.

Taxonomic coverage: Ecological areas, wetlands.

Status: Ongoing project, approximately 40 percent complete for contiguous States and 10 percent complete for Alaska. Hawaii inventory completed. Work is progressing at 5 percent per year for lower 48 States and 2 percent per year for Alaska.

Users: FWS, other Federal agencies, States, private organizations, others.

Contact: Bill Wilen, Coordinator, National Wetlands Inventory, Washington, DC.

References: (13,54).

7. **Wetland Plant Species Data Base**

Content: Information on habitat type, indicator status, FWS region of occurrence, and selected botanical references for wetland plant species found in the United States. Data are compiled from reference works, and independent verification of whether a plant indicates a wetland is made by experts of each plant.

Purpose: To assist biologists in wetland delineation.

Geographic coverage: National—all 50 States and Caribbean territories and trusts.

Taxonomic coverage: Plants.

Status: 4,000 plant species of 5,400 species known to be associated with wetlands have been entered into computer system. Proposed completion date in 1986.

Users: FWS, other Federal agencies, States, others.

Contact: Porter (Buck) Reed, Division of Biological Services, Wetlands Ecology Group, St. Petersburg, FL.

References: (43,64).

8. **Wetland Plant List Data Base**

Content: Compliment of plant species data (above) by providing on-line index of plant species scientific name, common name, synonyms, geographic locators, and indicator status.

Purpose: List may help biologists with rapid wetland delineations based on species presence.

Geographic coverage: National.

Taxonomic coverage: Wetland plants.

Status: In development stages, may be available in 1986.

Users: FWS biologists, other Federal agencies.

Contact: Porter (Buck) Reed, Division of Biological Services, Wetlands Ecology Group, St. Petersburg, FL.

Reference: (43).

9. **Endangered Species Information System (ESIS)**

Content: Biological, ecological, and distributional information available on each federally listed threatened and endangered species that occur within the United States or its territories.

Purpose: System will provide a centralized source for data on listed species, and will assist in consultation, permit review, planning coordination and recovery.

Geographic coverage: Will be nationwide.

Taxonomic coverage: Plants, birds, mammals, reptiles, amphibians.

Status: Initial development complete. Twenty-five species are in prototype database. Data collection on currently listed species is nearing completion. Projected date for system availability is 1987 to 1988.

Users: FWS, other Federal agencies, States, others (initially through FWS regional offices).

Contact: Bill Gill, Office of Endangered Species, Ballston, VA.

Reference: (24,26).

10. **Candidate Species List**
   Content: Published list of species of invertebrates, plants, and vertebrates that are or were considered formal candidates for listing as a threatened or endangered species. Candidates are considered in three categories: 1) enough data is available to initiate the listing process; 2) more data on species are needed for consideration for listing; and 3) species is presumed extinct, name given is invalid, or species was subject to formal review and found to not be endangered.
   Purpose: In-house list for identification of candidate species and tracking their current status.
   Geographic coverage: National.
   Taxonomic coverage: All species.
   Status: Plant list and vertebrate list updated and published in Federal Register in 1985. Invertebrate list is being updated currently; last published in 1982.
   Users: FWS, other Federal agencies, State agencies, others (conservation organizations).
   Contact: LaVerne Smith, Office of Endangered Species, Ballston, VA.
   Reference: (15,50).

11. **Habitat Suitability Index (HSI) Models**
   Content: The HSI models contain brief literature reviews of species-habitat requirements, and identify habitat factors important in limiting species distribution and occurrence. The models include a method of rating habitat values based on habitat variables.
   Purpose: For use in inventory, impact assessment, and fish and wildlife planning activities.
   Geographic coverage· National.
   Taxonomic coverage: Selected vertebrates and invertebrates.
   Status: Reports are published for 125 species, with additional species being added each year.
   Users: FWS, States, other Federal agencies, others.
   Contact: Team Leader, Western Energy and Land Use Team, Ft. Collins, CO, for publications.
   Reference: (46,59).

12. **Fish and Wildlife Reference Service**
   Content: Documents reports (and other technical material) from the Federal Aid in Fish and Wildlife Restoration Programs (Dingell-Johnson and Pittman-Robertson Acts), the Anadromous Fish Conservation Program, the Endangered Species Grants Program, the Cooperative Fishery and Wildlife Research Units, and State fish and wildlife agencies. The database also documents published papers, technical publications, theses, and species materials, such as endangered species recovery plans.
   Purpose: To provide an easily searchable database that documents a significant amount of FWS and related agency fish and wildlife research results.
   Geographic coverage: National.
   Taxonomic coverage: All fish and wildlife species and some plant species in habitat studies; i.e., essentially all biota.
   Status: The system is a searchable file (file 957) on the dialog system. This database is updated several times annually and it contains citations back to the 1950s. The system provides copies (paper or microfiche) on request for publications identified through on-line searching.
   Users: Anyone with access to dialog and with permission of the FWS.
   Contact: Ell-Piret Multer, Columbia National Fisheries Research Laboratory, Columbia, MO.
   References: (58).

13. **Waterfowl Breeding Ground Surveys**
   Content: Aerial and ground survey of waterfowl nesting areas in May and July to estimate the size of breeding populations of 10 species and to estimate production, respectively. Water areas also mapped and counted. Specific information on breeding adults, brood success, and habitat change recorded.
   Purpose: To set annual harvest regulations.
   Geographic coverage: Regional—focused on the Northern States and prairie pothole region.
   Taxonomic coverage: Waterfowl.
   Status: Annual effort. Data computerized and maintained by Migratory Bird Management office.
   Users: FWS, States, other Federal agencies, others (private organizations, flyway councils).
   Contact: Robert Blohm, Office of Migratory Bird Management, Patuxent Research Center, Laurel, MD.
   References: (53,64).

14. **Woodcock Singing Ground Survey**
   Content: Data collected from 20 stops along 1,000 survey routes.

Purpose: To develop an index of population size for the annual woodcock harvest and to determine regional population trends.
Geographic coverage: Regional—Northern States, Eastern Canada Provinces.
Taxonomic coverage: Birds—one species.
Status: Yearly survey in the spring, data computerized at Migratory Bird Management Office.
Users: FWS, States, others (researchers).
Contact: John Tautin, Office of Migratory Bird Management, Patuxent Research Center, Laurel, MD.
References: (20,53).

15. **Sandhill Crane Surveys**

Content: Annual survey of each of the recognized sandhill crane population. The mid-continent population is systematically surveyed aerially along the Platte River in the fall. Casual ground surveys also occur, and information on the population from North Dakota is available from the Bureau of Reclamation.

The eastern population of greater sandhill cranes are surveyed on the ground in mid-fall in northwestern Indiana.

The Rocky Mountain population is surveyed on the ground in the winter in the Rio Grande Valley. In 1985, a spring survey was conducted in a Colorado valley.

The Imperial Valley (California) population is surveyed on the ground during the winter.

The Central Valley (California) population is surveyed on the ground in the winter.

The Pacific Flyway lesser sandhill crane population is surveyed on the ground in the Central Valley in California during the winter.

The federally endangered Mississippi population of greater sandhill cranes is surveyed each winter in the bottomland hardwood areas of Mississippi.

Purpose: To determine population size and monitor trends in population. For some populations, data is used to set harvest limits.
Geographic coverage: Regional—Nebraska, Indiana, New Mexico, Texas, California, Mississippi, and vicinities.
Taxonomic coverage: Birds.
Status: Data contained in files within the States or on the refuges where the survey occurred. Office of Migratory Bird Management provides an unpublished report with raw and synthesized information each year. Data also summarized during International Crane workshop series held periodically (most recent workshop was March 1985 in Nebraska).
Users: FWS, Bureau of Reclamation, States, others (Audubon Society).
Contact: Harvey Miller, Office of Migratory Bird Management, Golden, CO.
Reference: (34).

16. **Great Lakes Commercial Catch Data Base**

Content: Data collection since the early 1920s on commercial fish catches in the Great Lakes from data forms submitted by States. Data include species caught, location information (lake, State), month of take, and total catch in pounds and dollar value.
Purpose: Data used for economic forecasting and to provide information on fish population levels.
Geographic coverage: Regional—Great Lakes.
Taxonomic coverage: Fish of commercial interest.
Status: Data collected and synthesized annually, computerized since 1971. Data summarized and sent to National Marine Fisheries Service for statistical analysis.
Users: National Marine Fisheries Service, States, others (Great Lakes Fish Commission).
Contact: Tony Frank, Great Lakes Fishery Laboratory, Ann Arbor, MI.
Reference: (22).

17. **Great Lakes Research Fishery Data Base**

Content: Data generated on Great Lakes fish population through spring and fall surveys at more or less fixed locations around the Great Lakes. Information include species, size, length frequency by species, and population distribution for commercial and forage species.
Purpose: To monitor fish populations.
Geographic coverage: Regional—Great Lakes.
Taxonomic coverage: Fish.
Status: Data gathered annually on targeted fish species and computerized. Data are published in annual reports and scientific papers.
Users: FWS laboratory personnel.
Contact: Will Hartmann, Great Lakes Fishery Laboratory, Ann Arbor, MI.
Reference: (22).

18. **FISHNET**

Content: Information collected on anadromous fisheries in the Columbia River Basin. Data are collected at specific locations and can be aggregated into stem segments, by subbasin, or compiled for the entire basin. Data include total fish production, total basin runs, available habitat, and spawning information.

Purpose: For fishery resource management and impact mitigation.

Geographic coverage: Regional—Columbia River Basin (Montana, Idaho, Washington, Oregon, Canada).

Taxonomic coverage: Anadromous fish.

Status: Data no longer being entered into system, since April 1985. Data included are only for chinook salmon to date. Restart for data-entry may occur during fiscal year 1986. Approximately 1,500 sets of information included, providing some data for about 1,000 stem segments.

Users: FWS Fishery Management personnel.

Contact: Wally Steuke, Office of Fisheries Management, Region 1, Portland, OR.

Reference: (51).

19. **Coastal and Marine Bird Data Base**

Content: Data consisted of migratory species within the continental United States (waterfowl, shorebirds, sea birds, and migratory birds) listed by region, State and various ecological units. Database provided some information on population estimates, feeding, breeding, and seasonal habitat requirements.

Purpose: To develop habitat management guidelines.

Geographic coverage: Regional—coastal areas.

Taxonomic coverage: Birds.

Status: Trial project; not continued.

Users: Currently none.

References: (49,64).

20. **Coastal Area Characterization Studies**

Content: Information on distribution, habitat association, population trends or relative abundance, and legal or protective status of selected flora and fauna in coastal areas. Data generated from literature and local, site-specific field files maintained by FWS or researchers.

Purpose: To identify areas where special management considerations are needed.

Geographic coverage: Regional—coastal and estuarine areas. Almost all of the Pacific and Gulf Coasts, about 50 percent of the Atlantic Coast (Maine, and South Carolina to Florida).

Taxonomic coverage: Birds, amphibians, reptiles, mammals, plants.

Status: Studies completed and published. No more work will be done on this project.

Users: FWS, other Federal agencies, States, others.

Contact: Harold Rienstra, Information Transfer Specialist, National Coastal Ecosystems Team, Slidell, LA, for publications.

References: (44,64).

21. **Coastal Ecological Inventory**

Content: Coastal resources of the Pacific, Atlantic and Gulf coasts. Information includes land-use designations, all important fish and wildlife species and their habitats, fish and wildlife species in need of special protection, and species use of specific coastal areas.

Purpose: Identify areas for management considerations for fish and wildlife.

Geographic coverage: Regional—Pacific, Atlantic, and Gulf coasts.

Taxonomic coverage: General habitat information for species of concern.

Status: Maps and narrative completed.

Users: FWS, other Federal agencies, States, others.

Contact: Harold Rienstra, Information Transfer Specialist, National Coastal Ecosystems Team, Slidell, LA, for publications.

References: (44,64).

22. **Coastal and Estuarine Species Profiles**

Content: Detailed information of selected coastal and estuarine species. Data includes food habits, distribution, habitat, and breeding information.

Purpose: To assist species planning and management in coastal areas.

Geographic coverage: Regional—coastal and estuarine areas.

Taxonomic coverage: Selected vertebrates and invertebrates.

Status: 30 profiles completed, 50 more in some stage of preparation.

Users: FWS, States, other Federal agencies, others.

Contact: Team Leader, National Coastal Ecosystems Laboratory, Slidell, LA.

Reference: (44).

23. **Marine and Waterbird Colony Data**

Content: Colony nesting bird data collected and synthesized in 5-year cycles for the Atlantic, Gulf, and Pacific coasts. Data include species occurrence, relative abundance of species within the colony, and location information.

Purpose: To monitor bird populations.
Geographic coverage: Regional—coastal areas.
Taxonomic coverage: Birds.
Status: Data are published in reports and some are available on computers at the regional offices. Atlantic survey done in 1975 to 1976 and never updated. Gulf coast was updated in the early 1980s. Pacific coast and Alaska data not updated since the 1970s.
Users: FWS, States.
Contact: Team Leader, Coastal Ecology Research Laboratory, Slidell, LA, for publications.
Reference: (49).

24. **T&E Species Sightings Data, Montana and Wyoming**
Content: Incidental sightings of endangered species in Wyoming and Montana: bald eagles, peregrine falcons, and grey wolves. Data include species, location, and any additional information available from confirmed sightings by field personnel or other people. Some data from midwinter bald eagle survey.
Purpose: Data used as baseline to evaluate potential impacts of proposed projects in Montana and Wyoming.
Geographic Coverage: Regional—Montana and Wyoming, and sometimes Idaho.
Taxonomic Coverage: Birds, mammals.
Status: Data entry sporadic and continuing.
Users: FWS personnel.
Contact: Wayne Brewster, Endangered Species Staff, Helena, MT.
Reference: (12).

25. **Plant Information Network**
Content: Data on species of interest and benefit to wildlife that could be used in surface mine reclamation. Species from Colorado, Wyoming, North Dakota, Utah, and New Mexico were included in system with information on value to wildlife, native county of origin, wildlife food or livestock grazing value, and water requirements.
Purpose: Data developed between 1977 and 1979 as a reference manual for people working with surface mine reclamation.
Geographic coverage: Regional—Western States.
Taxonomic coverage: Plants.
Status: System dismantled in 1982. Data available on tapes from FWS Western Energy Land Use Team in Ft. Collins, CO. Data published as FWS/OBS-83/36.
Users: FWS, other Federal agencies.
Contact: Lee Ischinger, Western Energy and Land Use Team, Office of Biological Services, Ft. Collins, CO.
Reference: (30).

26. **RAPTOR**
Content: Information on distribution, abundance, location, status, and species is collected for raptor nests within Utah, Colorado, Wyoming, and Montana. Species included are golden eagles, bald eagles, redtail hawks, ferruginous hawks, prairie falcons, and others. The system includes between 5,000 and 7,000 records of nest sitings and some habitat information where the nest was found.
Purpose: Data not used continuously but provide baseline information on raptor presence for project impact analysis, particularly surface mining operations.
Geographic coverage: Regional—Intermountain West; southeast Utah, West Colorado, parts of Montana and Wyoming.
Taxonomic coverage: Birds.
Status: System regularly updated at field offices. Regional database updated a few times each year.
Users: FWS, States.
Contact: George Bowen, Habitat Resources, Region 6, Denver, CO.
Reference: (6).

27. **Terrestrial Species Database**
Content: Information on bird species diversity relative to habitat type and habitat features for Powder River Basin area. Habitat maps were devised to correlate bird species diversity to habitat type.
Purpose: Data serve as a methodology model for regional rapid assessment of habitat quality values.
Geographic coverage: Regional—portions o Montana and Wyoming; Powder River Basin
Taxonomic coverage: Birds.
Status: Data generated during 1978 and 1979 Has not been updated. Data published a scientific paper and in files.
Users: Currently none.
Contact: Duane Asherin, Western Energy an Land Use Team, Office of Biological Ser ices, Ft. Collins, CO.
Reference: (4).

U.S. Geological Survey

1. **Land Use/Land Cover Data and Maps**
Content: Digital data on land use and land cov for development of 1:250,000 and 1:100,0

scale maps. Land categories include wetlands, barrenlands, rangelands, forest lands, tundra, etc., delineated down to a minimum map unit of 10 acres.

Purpose: To provide reference maps for land cover.

Geographic coverage: National.

Taxonomic coverage: Vegetation.

Status: Maps cover approximately 90 percent of the United States, with index of available maps updated each year.

Users: Federal agencies, States, others.

Contact: National Cartographic Information Center for maps or magnetic tapes of digital data; Midcontinent Mapping Center for maps from Midwest States; Rocky Mountain Mapping Center for maps of Rocky Mountain States; and Western Mapping Center for maps in Pacific States.

Reference: (72).

2. **Coastal Ecological Inventory**

Content: Maps include major land-use designation, important fish and wildlife species and their habitats, and locates plant and animal species in need of special attention.

Purpose: Maps (1:250,000 scale) compliment coastal manuals created by FWS.

Geographic coverage: Regional—Pacific, Atlantic, and Gulf coasts.

Taxonomic coverage: Plants and animals.

Status: Maps completed.

Users: Federal agencies, States, others.

Contact: National Cartographic Information Center, Reston, VA.

Reference: (20).

Summary of the U.S. Department of Agriculture

Similar to the Department of the Interior, the Department of Agriculture has no single source or clearinghouse for biological information. Two agencies in the Department of Agriculture were surveyed: the Soil Conservation Service and the Forest Service. The inventories of natural resource databases prepared for the Interagency Agreement Relating to Classifications and Inventories of Natural Resources (20) provided a starting point for database identification. In addition, a recent Forest Service effort to identify databases within the agency provided additional information about this agency (8).

Soil Conservation Service (SCS)

1. **National Resources Inventories**

Content: Inventories of land use and land cover, including data on vegetation, pasture and rangeland condition, riparian habitats, and fish and wildlife habitats. Data collected from permanent sample points by SCS local and State personnel. Resolution of data accurate to the State level and to the multi-county level (major land resource area) in 1977 and 1982, respectively.

Purpose: To monitor changes in land use and land cover, identify areas for resource conservation priorities, and other purposes.

Geographic coverage: National—generally non-Federal lands.

Taxonomic coverage: Vegetation, extrapolation about wildlife from habitat information.

Status: 1982 survey data collected, final analysis of the data occurring now.

Users: National trend data available to any party. Data used by other Federal agencies, States, others (individuals and conservation groups).

Contact: Gary Norstrom, Resources Inventory Division, Washington, DC.

Reference: (20,37).

2. **National Forest-Soil Data Base**

Content: Information on forest tree species in relation to soil series and soil series to windbreak species. Data collected by SCS personnel in field studies.

Purpose: Central clearinghouse of windbreak information and source of easily retrievable data for conservation work and report generation.

Geographic Coverage: National—non-Federal lands.

Taxonomic coverage: Vegetation, trees and shrubs.

Status: Data entered and updated as they become available from field studies.

Users: SCS biologists and conservationists, other Federal agencies, States, others.

Contact: James McClinton, South National Technical Center, Fort Worth, TX.

Reference: (55).

3. **National Range Database**

Content: Data from range management plans and range site inventories prepared by SCS personnel. Data includes vegetation cover by species and species abundance and potential forage production.

Purpose: Reference service for range conservation inventories completed and planning tool for range management.

Geographic coverage: National—majority of data from private lands in Southeast States and most western range States.

Taxonomic coverage: Range plants.

Status: Database in development stages. System may be accessible by the end of 1986 and will be updated approximately three to four times annually.

Users: SCS, other Federal agencies, others.

Contact: Clifford Carter, Ecological Sciences Section, South National Technical Center, Ft. Worth, TX.

References: (9,47).

4. **New England Animal Species Data Base**

Content: Information on the distribution, habitat, feeding, and nesting substrates for about 300 terrestrial vertebrates. Data include species name, habitat type, feeding substrate, nesting substrate, and special habitat needs, if any. It has the capability for generating feeding matrices and species list by county or by State.

Purpose: To assess baseline resources in project impact assessment.

Geographic coverage: Regional—New England States.

Taxonomic coverage: Mammals, birds, amphibians, and reptiles.

Status: Data in quasi-draft form, not necessarily an authoritative source.

Users: SCS project staff and State biologists.

Contact: Alan Anman, New England Water Resources Planning Staff, Durham, NH.

Reference: (3).

U.S. Forest Service (USFS)

Each of the nine Forest Service Regions maintain data files on fish and/or wildlife species and their habitats. These are known as Wildlife (and Fish) Habitat Relationships (WHR) Programs. Included in the listing for this agency are examples of the WHR Programs.

1. **Forest Inventory and Analysis**

Content: Inventories of forest land in the continental United States, excluding Forest Service and BLM lands. Data collected from USFS personnel with some intergovernmental support. Data are aggregated by Society of American Foresters forest-cover types.

Purpose: To monitor forest lands.

Geographic coverage: National—forest lands not managed by BLM or USFS.

Taxonomic coverage: Vegetation—timber and some other forest data.

Status: Ongoing—Data updated on 10-year cycle with some States inventoried each year. Data are automated and available at regional level.

Users: USFS for trend analysis, other Federal agencies, State agencies.

Contact: James T. Bones, Forest Resources Economics Research Staff, Washington, DC.

References: (20,63).

2. **Range Analysis**

Content: Continuous inventory of range condition on all national forest rangelands, including data on existing and potential vegetation. Data tabulated and available on maps at 1 inch:1 mile scale.

Purpose: To monitor range condition on national forest lands.

Geographic coverage: National—national forest rangelands.

Taxonomic coverage: Vegetation.

Status: Ongoing inventory procedure, data used for FSRAMIS.

Users: Forest Service.

Contact: Range Resources Staff, Rosslyn, VA.

Reference: (47).

3. **FSRAMIS**

Content: Permittee, number of animal unit months and animals, vegetation inventory, site production for each range allotment. Data on range plants generated using Range Analysis method. FSRAMIS also will include Wild Horse and Burro Territorial Plans; allotments designed similar to livestock allotments for horse and burro herds.

Purpose: To track allotment information.

Geographic coverage: National—national forest lands with livestock allotments.

Taxonomic coverage: Range plants.

Status: In development stage. Region 1 has system almost complete, regions 2 and 4 only partially completed. System will be available at each regional office and be coded by allotment.

Users: National forest staff.

Contact: Range Resources Staff, Rosslyn, VA.

Reference: (47).

4. **RPA Range Data**
   Content: Data on all rangelands in the United States coordinated by the Forest Service from forest plans, from BLM grazing Environmental Impact Statements, and from SCS in their National Resources Inventories data. Data are aggregated at ecosystem level. Data are 75 to 80 percent accurate at the ecosystem level.
   Purpose: To prepare summaries of range condition, trends, productivity, and potential.
   Geographic coverage: National—all rangelands.
   Taxonomic coverage: Range vegetation.
   Status: Ongoing effort, with data currently being updated for the 1989 assessment.
   Users: Federal agencies, States, others.
   Contact: Linda Joyce, Resource Specialist, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.
   Reference: (47).

5. **Research Natural Areas**
   Content: Continuing inventory for existing and proposed Research Natural Areas. Data include timber and range vegetation types.
   Purpose: To determine whether areas proposed for RNA status contain vegetation types not represented in the RNA system.
   Geographic coverage: National—Forest Service RNAs in 33 States and Puerto Rico.
   Taxonomic coverage: Vegetation.
   Status: Continuous data-entry and system update. Data file maintained by The Nature Conservancy.
   Users: USFS, others.
   Contact: Russell Burns, Timber Management Research Staff, Rosslyn, VA.
   Reference: (20).

6. **Resource Planning Act (RPA) Wildlife Data**
   Content: Data include terrestrial and aquatic vertebrates listed by Forest Service Region, State, national forest, and generally by ecosystem, vegetation type, and seral stage. Data cover habitat associations and detail population estimates for consumptive-use species.
   Purpose: Information used to identify trends in the wildlife and fish portion of the RPA assessment.
   Geographic coverage: National—all forests, ranges, and croplands in the 1989 assessment.
   Taxonomic coverage: Mammals, birds, amphibians, reptiles, and fish.
   Status: Data currently being updated for 1989 assessment. Joint Forest Service RPA and Soil Conservation Service RCA assessment in 1989.
   Users: USFS, SCS, other Federal agencies, States, others.
   Contact: Thomas Hoekstra, Rocky Mountain Forest and Range Experiment Station, Forest Service, Ft. Collins, CO.
   David Chalk, West National Technical Center, Soil Conservation Service, Portland, OR.
   Reference: (29).

7. **RUN WILD**
   Content: Data on terrestrial vertebrates and fish by county and national forest. Data include habitat association and information on legal and protected status of the species.
   Purpose: To assist fish and wildlife management planning and impact analysis.
   Geographic coverage: Arizona and New Mexico.
   Taxonomic coverage: Mammals, birds, reptiles, amphibians, fish—approximately 1,000 species.
   Status: Updated approximately annually. Information available on microfiche, in publications, and in computer programs.
   Users: USFS, other Federal agencies, States, others.
   Contact: Rick Wadleigh, Wildlife Unit, Southwestern Region, Albuquerque, NM.
   Reference: (65).

8. **WILDHAB**
   Content: Data on amphibians, reptiles, birds, mammals, and fishes by county, State, and national forest. Data includes habitat association, special habitat features, relative abundance, reproductive potential and performance, food habits, and legal or protective status.
   Purpose: To assist fish and wildlife management planning and impact analysis.
   Geographic coverage: Regional—Oregon, Washington, and northern California.
   Taxonomic coverage: Mammals, birds, reptiles, amphibians, fish.
   Status: Updated periodically as data become available. Data available in publications and through computer system in Ft. Collins, CO.
   Users: USFS, State, others—system difficult to access.
   Contact: Dick Holthausen, Fish and Wildlife Staff, Pacific Northwest Region, Portland, OR.
   Reference: (68)

9. **Roadless Area Review and Evaluation (RARE) Phase II**
   Content: Comprehensive inventory of national forest roadless and undeveloped areas. Data on land cover (vegetation) and wildlife species within these areas are very general. Data coded by location and physiographic region. (NOTE: Data from National Forest Management Plans generally more accurate than RARE data file.)
   Purpose: To identify areas with potential wilderness designations.
   Geographic coverage: Regional—national forest roadless areas.
   Taxonomic coverage: Vegetation cursory wildlife information.
   Status: Data still computerized but generally outdated with limited reliability. System completed in 1979 with sporadic updates and revisions.
   Users: USFS, infrequently.
   Contact: Land Management Planning Staff within each regional office.
   Reference: (33).

10. **Inventory Database for Timber Management Planning**
   Content: Data on timber resources for each of the national forests. Data updated about every 10 years and stored at each forest.
   Purpose: To support USFS planning efforts.
   Geographic coverage: Sub-State—national forest lands.
   Taxonomic coverage: Vegetation—timber.
   Status: Ongoing data collection on site-specific basis.
   Users: USFS Planners at forest, regional, and national levels, States, others (conservation groups).
   Contact: Forest Service planning staff on each national forest.
   Reference: (20).

11. **Fuels Inventory**
   Content: Site-specific inventories of fuelwood in national forests are completed on the local level. Inventories are conducted on an as-needed basis, and no consistent inventory procedures are used.
   Purpose: To determine fire hazards and treatment needs, and for annual reports on acres treated to reduce fuel build-up.
   Geographic coverage: Sub-State—site-specific areas in national forests.
   Taxonomic coverage: Vegetation.
   Status: Ongoing data collection on each forest as needed.
   Users: Forest managers to determine timber treatments.
   Contact: Forest Management Staff in each national forest.
   Reference: (20).

12. **Timber Stand Analysis and Silviculture Prescription**
   Content: Stand-specific inventories of timber supply and condition on approximately 5 million acres of forest land each year.
   Purpose: To assist in national forest planning and monitor silviculture operations.
   Geographic coverage: Sub-State—commercial forest stand on national forests.
   Taxonomic coverage: Vegetation.
   Status: Continuous inventory collection at the forest level. Some data are automated and others are available in map form.
   Users: Forest managers, States.
   Contact: Forest Management Staff on each national forest.
   Reference: (20).

13. **California Wildlife Habitat Relationships (WHR) Programs**
   Content: Data on species of amphibians, reptiles, birds, mammals by county and national forest. Species included are resident or common migrants to State. Data include habitat association, special habitat features, legal or protective status and general food, cover and reproduction needs. Habitat classification systems differ between zones. Data presented as species note (one-page summary), species distribution map, and species/habitat matrix. Data published and available in computerized form by zone. The four California zones are listed below.
   Purpose: To assist fish and wildlife management planning and impact analysis.
   Reference: (28,32).

a) Western Sierra WHR Program
   Geographic coverage: Sub-State—selected national forests in California.
   Taxonomic coverage: Birds, mammals, amphibians, and reptiles.
   Status: System available through Ft. Collins, CO, and in published form. Data not updated since 1980.
   Users: Forest Service, other Federal agencies, States, others.

Contact: William Laudenslayer, Wildlife Staff, Tahoe National Forest, Nevada City, CA.

b) North Coast Cascades WHR Program
  - *Geographic coverage:* Sub-State—northwestern California National Forests.
  - *Taxonomic coverage:* Mammals, birds, amphibians, and reptiles.
  - *Status:* Data compiled, published, and computerized in 1980 and 1981. Data not updated since publication. Data also available on microcomputer (32).
  - *Users:* Forest Service, other Federal agencies, States, others.
  - *Contact:* William Laudenslayer, Wildlife Staff, Tahoe National Forest, Nevada City, CA.

c) North East Interior WHR Program
  - *Geographic coverage:* Sub-State—interior national forests from Lassen into Great Basin.
  - *Taxonomic coverage:* Mammals, birds, amphibians, and reptiles.
  - *Status:* Data published and computerized from 1980 through 1982. No updates have been made.
  - *Users:* Forest Service, other Federal agencies, States, others.
  - *Contact:* William Laudenslayer, Wildlife Staff, Tahoe National Forest, Nevada City, CA.

d) Southern California WHR Program
  - *Geographic coverage:* Sub-State—selected national forests in southern California.
  - *Taxonomic coverage:* Mammals, birds, amphibians, and reptiles.
  - *Status:* Publication in draft stage. Maps and computerization not completed. In this zone, habitat matrices will be designed differently from other California zones. The system will not have species notes.
  - *Users:* Forest Service, other Federal agencies, States, others.
  - *Contact:* William Laudenslayer, Wildlife Staff, Tahoe National Forest, Nevada City, CA.

Summary of the U.S. Department of Commerce, National Oceanographic and Atmospheric Administration

NOAA maintains a series of data centers within the Administration: the National Environmental Data Referral Service (NEDRES) and the National Ocean Data Center are examples. Data available from these centers include biological inventories from a variety of sources within the Administration. The following list provides examples of the kinds of data available within three different services within NOAA: the Office of Oceanography and Marine Assessment of the National Ocean Office; the National Marine Fisheries Service; and the National Oceanographic Data Center within the National Environmental Satellite, Data and Information Service.

Office of Oceanography and Marine Assessment, National Ocean Service

1. **Marine Living Resource Database**
   - *Content:* Data collected and mapped on approximately 100 vertebrates and selected invertebrates found in the Exclusive Economic Zone (EEZ). Species include marine mammals, some coastal birds, fish of economic or sport value or forage value for economic species and invertebrates of economic value. Data on each species include location as juveniles and adults, qualitative information on concentration within a given area, and digitized locational data for mapping. Database also contains information on pollution discharges in coastal counties and population and economic data by coastal county.
   - *Purpose:* To monitor marine resources relative to human activities in EEZ.
   - *Geographic coverage:* Regional—coastal areas.
   - *Taxonomic coverage:* Mammals, birds, fish, invertebrates.
   - *Status:* East coast file completed in 1978 and 1979 and has not been updated. Gulf coast data compiled between 1980 and 1983 and has not been updated. Pacific data compilation just getting started. Arctic Alaska data compilation began in 1980 and is just finishing.
   - *Users:* Other Federal agencies, NOAA, States.
   - *Contact:* Tim Goodspeed, Strategic Assessment Branch, Ocean Assessment Division, Rockville, MD.
   - *References:* (17,25).

2. **National Estuarine Inventory**
   - *Content:* Estuarine areas throughout the coterminous United States. Much of the data cover physical parameters of estuarine areas but biological data and land use are included.
   - *Purpose:* Data are designed to assist in assessment of resource uses in coastal and estuarine systems. A goal of the system is to evaluate and identify marine and estuarine resource development strategies that result in maximum public benefit and minimum environmental damage.

Geographic coverage: Regional—coastal and estuarine areas.
Taxonomic coverage: Vegetation.
Status: Atlas in draft form with final product expected in early 1986. The database is being developed.
Users: NOAA, Federal agencies, States, others.
Contact: Strategic Assessment Branch, Ocean Assessments Division, Rockville, MD.
Reference: (56).

National Marine Fisheries Service (NMFS)

The NMFS Annual Report for 1983 to 1984 on marine mammals details 19 studies conducted on marine mammals within the four NMFS regions. Two of the inventories discussed in the Annual Report are presented here. Additionally, the National Marine Fisheries Service maintains four regional fisheries research and management centers and associated labs: The North Atlantic in Woods Hole, MA; the South Atlantic in Miami, FL; the Pacific Southwest in La Jolla, CA; and the Northwest and Alaska in Seattle, WA. Each Center maintains data files for biological resources under their jurisdiction. Included here are examples of biological databases from the Northwest and Alaska Fisheries Center.

1. **Fisheries of the United States**
   Content: Information on commercial catch or landings by U.S. fishermen and foreign fishing vessels within the U.S. Fishery Conservation Zone.
   Purpose: To monitor harvests and trends in fishing industry.
   Geographic coverage: Regional—indexes of landings within the Fishery Conservation Zone.
   Taxonomic coverage: Finfish and shellfish of economic or commercial importance.
   Status: Data summarized in annual reports along with numerous statistics about the fishing industry and markets. The most recent report includes preliminary information for 1984. Raw data are stored in the Fisheries Statistics Office of NMFS.
   Users: NOAA, States, others.
   Contact: Commercial Fisheries Statistics Office, Washington, DC.
   Reference: (19).

2. **Marine Recreational Fishery Statistics Survey**
   Content: Data on recreational fisheries caught in marine waters. Surveys are summarized in reports that include estimates of number and weight of fish caught as well as species information collected from telephone interviews and field surveys.
   Purpose: To monitor fishery harvests.
   Geographic coverage: Regional—marine waters along the Atlantic, Gulf, and Pacific coast.
   Taxonomic coverage: Finfish of recreational importance.
   Status: Most recent report covers fish catches and species from 1981 and 1982. Reports compiled on a time-allowed basis.
   Users: NOAA, States.
   Contact: Recreational Fisheries Statistics Office, Washington, DC.
   Reference: (18).

3. **Bowhead Whale Census**
   Content: Information on populations and location of bowhead whales in the Pacific.
   Purpose: To develop population estimates of bowheads in the Pacific. Data used to establish takes and harvestable populations.
   Geographic coverage: Regional—Pacific marine areas.
   Taxonomic coverage: Bowhead whales, single species.
   Status: Census of whale populations is ongoing.
   Users: NMFS, Congress, others.
   Contact: National Marine Mammal Laboratory, Settle, WA.
   Reference: (57).

4. **Icthyoplankton Survey Database**
   Content: Data on icthyoplankton resources from grid of stations visited approximately quarterly each year. Data collected by Soviet research vessels as well as NMFS vessels, under cooperative agreements. Approximately 200 species are surveyed.
   Purpose: To estimate spawning biomass of commercially important fish species.
   Geographic coverage: Regional—Pacific Ocean areas.
   Taxonomic coverage: Fish—icthyoplankton.
   Status: Data collection ongoing annually. From California to Washington, data have been generated and computerized for past years. Data from Alaska area available since around 1973. Data from the Bering Sea available since around 1975.
   Users: NMFS staff.
   Contact: Arthur Kendall, Resource Ecology and Fisheries Management Section, Alaska and Northwest Fisheries Center, Seattle, WA.
   Reference: (16).

5. **RACE Ground Fish Database**

Content: Wide series of monitoring and special study inventories of biological resources within their jurisdiction. Monitoring surveys are done every 3 years in the eastern Bering Sea, Aleutian area, Gulf of Alaska, and along the Pacific coast from northern California to northern Washington. Data generated from trawling efforts, acoustic or "semi-pelagic" surveys, trapping surveys and intensive, sight specific studies (e.g., on sea mounts in Gulf of Alaska). Data grouped taxonomically and sorted by location, inventory effort, and taxa.

Purpose: Data create time series of change in abundance, species distribution, and age structure.

Geographic coverage: Regional—northwest coast of coterminous United States.

Taxonomic coverage: 2,400 species and species' groups of fish, aquatic vertebrates and invertebrates.

Status: System computerized and interactive. Data updated continuously.

Users: NMFS, States, Fisheries Commissions (e.g., International Pacific Halibut Commission), private researchers.

Contact: Susan Picquelle, Data Manager, Resource Assessment and Conservation Engineering Center, Alaska and Northwest Fisheries Center, Seattle, WA.

References: (2,42).

6. **Northern Fur Seal Study**

Content: Information includes the age of fur seals harvested, the number of adult males on the rookeries and hauling grounds and number of pups and older seals that die on the rookeries and adjacent beaches. Behavioral studies also are ongoing.

Purpose: Studies are ongoing on potential causes of decline of northern fur seal population levels.

Geographic coverage: Sub-State—Pribilof Islands, mainly St. Paul and St. George.

Taxonomic coverage: Northern fur seal, single species data.

Status: Studies on behavior, breeding, and take of the northern fur seal are ongoing.

Users: NOAA, States, others.

Contact: National Marine Mammal Laboratory, Seattle, WA.

Reference: (57).

National Environmental Satellite, Data and Information Service

1. **National Oceanographic Data Center (NODC)**

Content: NODC provides a clearinghouse for physical, chemical, and biological data collected both by U.S. agencies within and outside of NOAA and data collected under international agreement. Examples of the biological data files available through NODC are listed below.

Users: Available to anyone; fees charged to recover operating costs.

Contact: NODC User Services Branch, Washington, DC.

Reference: (36).

a) File 002, Benthic Macrofauna

Content: Raw data on number of individuals and mass of organisms of macrofauna.

Purpose: To provide baseline information on population densities and distribution.

Geographic coverage: Sub-State—Mid-Atlantic and U.S. Gulf coast.

Taxonomic coverage: Bottom dwelling macrofauna.

Status: Data collected from 1975 to 1979.

b) File 009, Marine Bacteria

Content: Data from studies of water column and bottom in numbers per unit volume.

Purpose: To identify density and location of organisms.

Geographic coverage: Sub-State—U.S. Gulf coast.

Taxonomic coverage: Heterotrophic, hydrocarbonoclastic, or halophilic bacteria.

Status: Data collected from 1975 to 1979.

c) File 028, Phytoplankton

Content: Data collected on abundance, distribution, and productivity.

Purpose: To identify primary production in marine areas.

Geographic coverage: Sub-State—coastal Alaska, Puget Sound, and U.S. Gulf of Mexico.

Taxonomic coverage: Vegetation-phytoplankton.

Status: Data collected from 1960 to present.

d) File 030, Intertidal Organisms and Habitats

Content: Data on species abundance and distribution of organisms.

Purpose: To provide baseline information.

Geographic coverage: Sub-State—coastal Alaska.

Taxonomic coverage: Vegetation and aquatic animals.

Status: Data collected from 1974 to 1980.

e) File 033, Marine Bird Sighting, Ship/Aircraft Census

Content: Sightings recorded from more or less fixed transect routes.
Purpose: To identify population density and distribution.
Geographic coverage: Sub-State—coastal Alaska and North Pacific.
Taxonomic Coverage: Birds.
Status: Data collected from 1975 to 1982.

f) File 034, Marine Bird Sighting, Land Census
Content: Recorded sightings along fixed transects.
Purpose: To establish population densities, distribution, and breeding locales.
Geographic coverage: Sub-State—coastal Alaska.
Taxonomic coverage: Birds.
Status: Data collected from 1975 to 1980.

g) File 100, Intertidal/Subtidal Organisms and Habitats
Content: Population data on species with some data on individuals, such as age, sex, and measurements.
Purpose: To establish population densities and distributions by species.
Geographic coverage: Sub-State—Puget Sound.
Taxonomic coverage: Aquatic animals, vegetation.
Status: Data collected from 1974 to 1979.

h) File 123, Fish/Shellfish Surveys
Content: Data from mid-water and bottom tow catches on weight, volume, and number per unit volume by total catch and by species.
Purpose: To establish density and distribution measures.
Geographic coverage: Sub-State—coastal Alaska, Puget Sound, U.S. Gulf coast.
Taxonomic coverage: Aquatic animals—mostly commercially important fish and shellfish species.
Status: Data collected from 1975 to present.

i) File 124, Zooplankton
Content: Data from studies of marine populations and ecosystems.
Purpose: To establish population abundances, distributions, and productivities.
Geographic coverage: Sub-State—coastal Alaska, Puget Sound, and U.S. Gulf coast.
Taxonomic coverage: Aquatic animals.
Status: Data collected from 1975 to present.

j) File 127, Marine Animal Sighting and Census
Content: Data from individual, random sightings and from sightings during systematic surveys of populations and individuals.
Purpose: To identify population densities, distributions, activities, migratory routes, and breeding locales.
Taxonomic coverage: Aquatic organisms, mammals.
Status: Data collected from 1981 to 1982.

k) File 132, Benthic Organisms
Content: Data from point sampling, photographic surveys, etc., along the ocean floor.
Purpose: To identify abundance, distribution, and biomass of populations.
Geographic coverage: Sub-State—coastal Alaska, and U.S. Gulf of Mexico.
Taxonomic coverage: Aquatic animals, vegetation.
Status: Data collected from 1971 to present.

Miscellaneous Federal Agencies

Department of Defense

Department of Defense agencies inventory resources on military installations that are sufficient size for natural resource management applications. These inventories are embodied in resource management plans. For example, the Marine Corps has natural resource plans for 10 of its installations. These plans cover endangered species and general fish and wildlife, and 6 of the 10 installations also have timber management plans (1). Likewise, the U.S. Air Force has 131 current natural resource management plans in 44 States or U.S. territories.

All military installations maintain some form of data on threatened or endangered species that reside or migrate through the installations. In addition, the U.S. Army Corps of Engineers collects baseline biological information on projects and activities under its jurisdiction. Although the Corps of Engineers is not considered a principal source of biological data, an example of the kind of data they manage is provided below.

Army Corps of Engineers (COE)

1. **Benthic Resources Assessment Project**
Content: Technique for analyzing bottom sediments for food resources that could be available for fish. Data generation is currently underway in four COE districts.
Purpose: Based on food availability, determinations are made on capability of area to sustain fish populations.
Geographic coverage: Regional—Chesapeake Bay, Mississippi Sound, others.
Taxonomic coverage: Benthic invertebrates.
Status: Pilot project stage. Results from initial surveys will be published in fiscal year 1986.
Users: COE Districts.

Contact: Project Manager, Waterway Experiment Station, Vicksburg, MS.
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Appendix B

List of Acronyms in Test

ACM	—Association for Computing Machinery
ADP	—automated data processing
AUM	—animal unit month (range forage needed to feed one cow and her calf for 1 month)
APHIS	—Animal and Plant Health Inspection Service
ASC	—Association of Systematic Collections
BIA	—Bureau of Indian Affairs, U.S. Department of the Interior
BLM	—Bureau of Land Management, U.S. Department of the Interior
CGIS	—Canada Geographic Information System
COE	—Corps of Engineers, U.S. Army
CRS	—Congressional Research Service, U.S. Congress
DBMS	—database-management system
DOD	—Department of Defense
EEZ	—Exclusive Economic Zone
EIS	—Environmental Impact Statement
EPA	—Environmental Protection Agency
ESA	—Endangered Species Act
ESIS	—Endangered Species Information System Data Base
FS	—Forest Service, U.S. Department of Agriculture
FSRAMIS	—Forest Service Range Analysis and Management Information System Data Base
FWS	—Fish and Wildlife Service, U.S. Department of the Interior
FY	—fiscal year (October 1 to September 30 for Federal Government)
GIS	—geographic information system
GRASS	—Geographical Resources Analysis Support System Data Base
IAALC	—Interagency Assessment and Appraisal Liaison Committee
IEEE	—Institute of Electronic and Electrical Engineers.
IHICS	—Integrated Habitat Inventory and Classification System
MFWIS	—Multi-state Fish and Wildlife Information System
MMC	—Marine Mammal Commission
MMS	—Minerals Management Service
NA	—National Arboretum, U.S. Department of Agriculture
NEDRES	—National Environmental Data Referral Service
NEPA	—National Environmental Policy Act
NMFS	—National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
NOAA	—National Oceanic and Atmospheric Administration, U.S. Department of Commerce
NP	—National Park
NPFLORA	—National Park Flora Data Base
NPS	—National Park Service, U.S. Department of the Interior
NRI	—National Resources Inventories
OBS	—Office of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior
ORNL	—Oak Ridge National Laboratory
OTA	—Office of Technology Assessment, U.S. Congress
RACE	—Resource Assessment and Conservation Engineering
RAIDS	—Riparian/Aquatic Information Data System
RARE	—Roadless Area Review and Evaluation
RCA	—Soil and Water Resources Conservation Act
RNA	—Research Natural Area
RPA	—Forest and Rangeland Renewable Resources Planning Act
RSI	—Range Site Inventory Data Base
SCS	—Soil Conservation Service, U.S. Department of Agriculture
SI	—Smithsonian Institution
SIGMOD	—Special Interest Group for Management of Data
SOMA	—Spotted Owl Management Area
STORMS	—Intensive Forest Survey Inventories Data Base
STRI	—Smithsonian Tropical Research Institute
SVIM	—Soil Vegetation Inventory Method Data Base
T&E	—Threatened and Endangered (Species)
TNC	—The Nature Conservancy
TPCC	—Timber Production Capability Classification Data Base
USDA	—U.S. Department of Agriculture
USFS	—U.S. Forest Service, U.S. Department of Agriculture
USGS	—U.S. Geological Survey, U.S. Department of the Interior
WHR	—Wildlife Habitat Relationships
5 WAY	—Interagency Agreement Relating to Classifications and Inventories of Natural Resources

Appendix C

Glossary of Terms

Attribute: A characteristic; for example, attributes of data include record length, record format, data set name, and so on.

Baseline: The standard from which change is measured.

Biological diversity: The variety and variability within and among living organisms and the ecological complexes in which they occur.

Biota: The living organisms of a region.

Bit: Contraction of "binary digit." A bit is the smallest unit of information in a binary system of notation (8 bits equals 1 byte).

Byte: A sequence of adjacent binary digits (bits) operated on as a unit; the minimum code necessary to specify a single character (e.g., "A").

Communities: Aggregation of organisms characterized by a distinctive combination of two or more ecologically related species (e.g., deciduous forest).

Data: The plural of datum.

Data bank: An organized collection of data.

Database: A structured collection of information as an entity in itself, or a collection of related files treated as an entity, which can be manipulated.

Database-management system (DBMS): A software system that provides access to a database and accommodates a variety of different applications using the same data.

Data element: A class or category of data based on natural or assigned relationships.

Data file: A collection of related data records organized in a specific manner.

Datum: A piece of information. Normally conveys little information as an independent item, but can convey information when used with other items of data.

Digital: In the form of numbers from 0 to 9.

Documentation: The creation, collection, organization, storage, citation, and dissemination of recorded information.

Ecosystem: An ecological community together with its physical environment, considered as a unit.

Ecotype: Genetically distinct population within the same species adapted to different environments.

Fauna: Organisms of the animal kingdom.

Flora: Organisms of the plant kingdom.

Gene: A chemical unit of hereditary information that can be passed from one generation to another.

Genus: A category of biological classification ranking between the family and the species, comprising structurally or phylogenetically related species or an isolated species exhibiting unusual characteristics.

Geographic information system (GIS): A special data system that incorporates explicit spatial data.

Habitat: The place or type of site where a plant or animal naturally or normally lives, grows, or reproduces.

Hardware: Physical equipment, as opposed to a computer program or method of use, for example, mechanical, magnetic, electrical, or electronic devices.

Interspecific: Between different species.

Inventory: The site collection of data on natural resources and their properties.

Magnetic storage: The storage of data by means of devices that use the magnetic properties of certain materials such as magnetic tapes and films.

Mainframe: A large computer system capable of supporting the activities of many users on an essentially simultaneous basis. Computing capacity, speed, and storage exceed that of the mini- or micro-computer.

Memory: The capacity of a computer to store and recall information.

Microcomputer: A small computer designed principally for use by an individual.

Minicomputer: A small computer that is generally configured for simultaneous use by a small number of people. Larger and more powerful than a microcomputer.

Modem: A piece of hardware that converts computer codes into signals that can be transmitted over telephone lines and reconverts such signals into computer codes.

Nutrient cycling: The process by which substances or minerals are transferred among organisms within a given location.

On-site: Within the natural or original environment.

Organism: A living being.

Phenotype: An observable characteristic of an organism.

Population: A group of organisms (of the same species) occupying a specific geographic area.

Remote sensing: Any means of gaining information without direct contact.

Resolution: The level of detail achieved in an inventory; for example, data is described as high-resolution if the inventory provided information on biological resources in minute detail.

Software: A set of programs that provide the operational structure of a data processing system.

Species: A taxonomic category ranking immediately below genus, and including closely related, morphologically similar individuals that actually or potentially interbreed.

Subspecies: A taxon of distinct, geographically separated complexes of genes, immediately below species.

Taxon: A taxonomic group or entity (plural: taxa).

Taxonomy: A hierarchical system of classifying organisms that best reflects the totality of similarities and differences.

Telecommunication: Data transmission between a computer system and remotely located devices via a unit that performs the necessary format conversion and controls the rate of transmission.

Voucher specimens: Specimens of plants or animals collected and preserved for the purpose of taxonomic identification or verification.

Wildlife: Living, nondomesticated animals.

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